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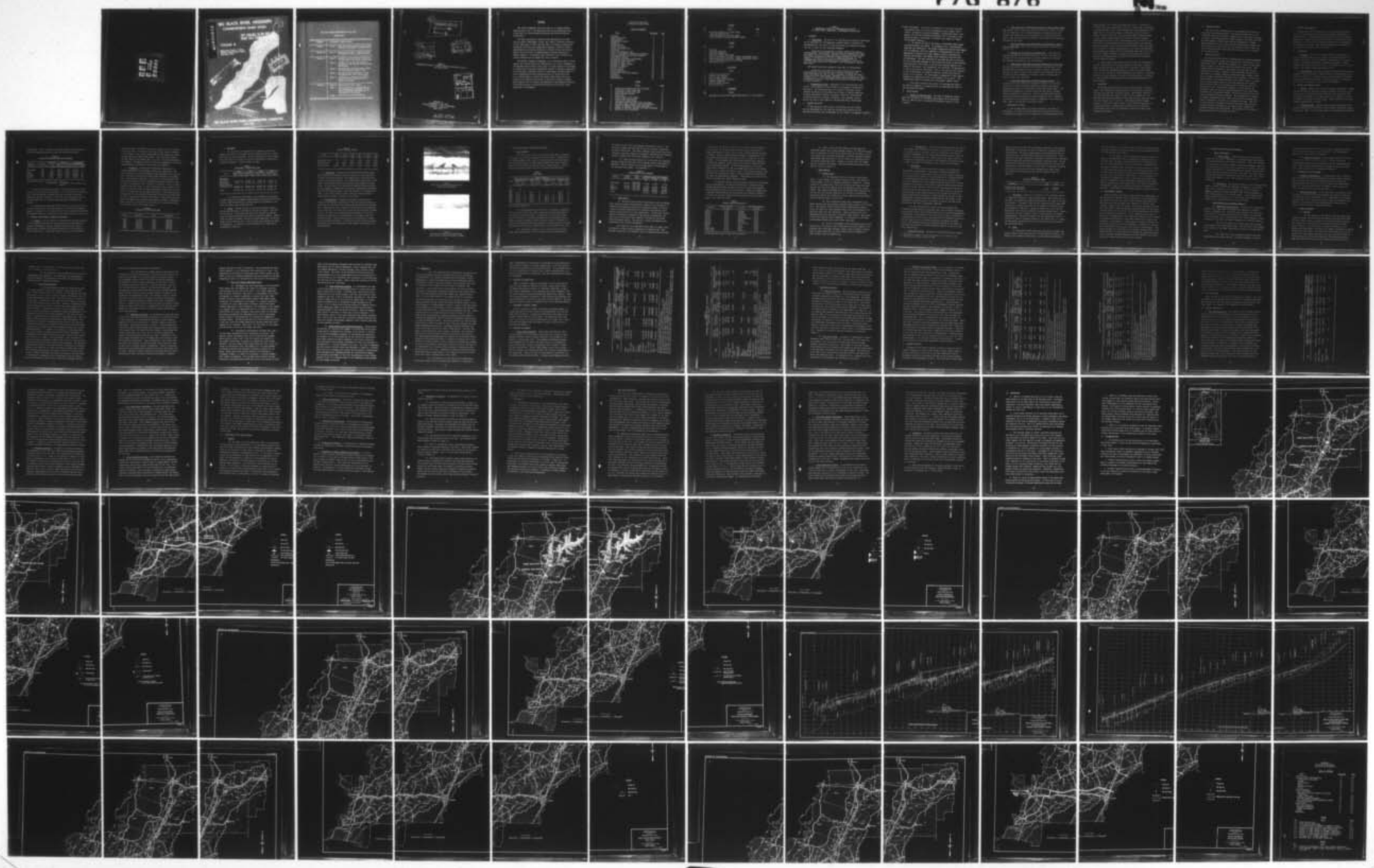

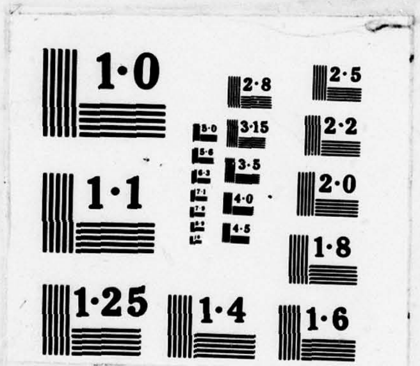
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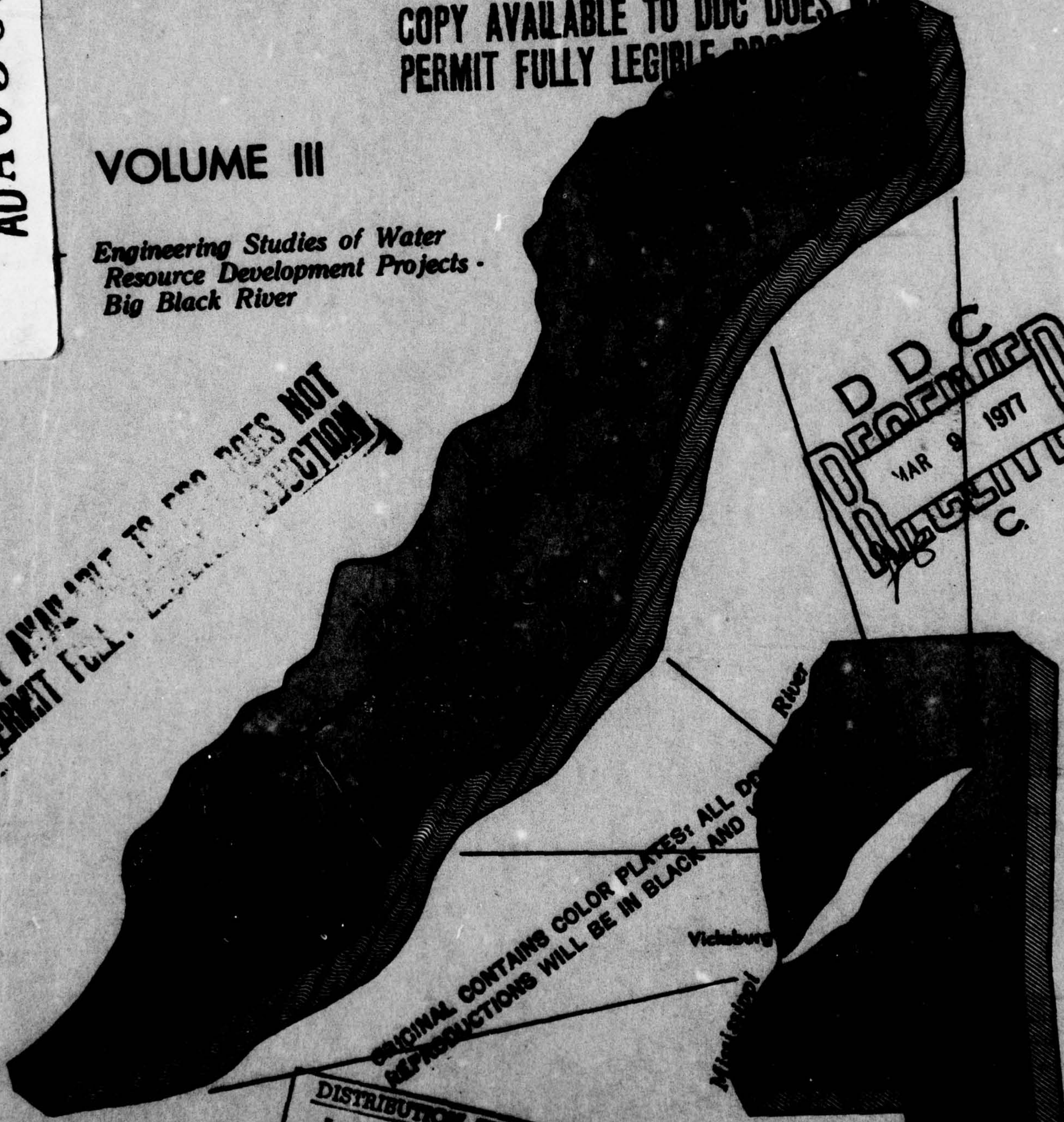
BIG BLACK RIVER, MISSISSIPPI

COMPREHENSIVE BASIN STUDY

VOLUME III

Engineering Studies of Water Resource Development Projects - Big Black River



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BIG BLACK RIVER COMPREHENSIVE BASIN STUDY

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COMPREHENSIVE BASIN STUDY.
Volume III.
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ANNEX B
ENGINEERING STUDIES OF WATER RESOURCE DEVELOPMENT PROJECTS
BIG BLACK RIVER

PREPARED BY
DEPARTMENT OF THE ARMY
VICKSBURG DISTRICT, CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI
APRIL 1968

SYLLABUS

The District Engineer finds that there is a flooding problem along the main stem of the Big Black River and an unsatisfied need in the basin for water-oriented recreation and fish and wildlife conservation.

All plans considered to provide flood protection on the main stem by channel improvement, levees, main stem or tributary reservoirs or any combination of these fall far short of economic justification. Recreation reservoirs are economically feasible. However, Federal participation in recreation projects is limited by law, and does not permit the construction of single-purpose recreation projects by Federal agencies. In addition, major reservoirs would inundate productive farmland and are opposed by local interests.

The District Engineer recommends: (1) no additional work for flood control and related purposes be undertaken by the Corps of Engineers in the Big Black River Basin at this time; (2) basin counties be encouraged to request that flood plain information reports be prepared; appropriate use of available technical services be encouraged; and improvement of flood forecasting and flood warning services be continued by the U. S. Weather Bureau; (3) main stem channel improvement for flood control be restudied in the future if the basin's economic development warrants; and (4) further consideration of multipurpose reservoirs on the main stem and on selected tributaries for the basin's long range plan of development

BIG BLACK RIVER BASIN
COMPREHENSIVE BASIN STUDY

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BIG BLACK RIVER, MISSISSIPPI, COMPREHENSIVE BASIN STUDY

1. AUTHORITY

a. Resolutions. The study of the Big Black River Basin was authorized by two resolutions of the Committee on Public Works of the House of Representatives. The first of these resolutions was adopted 16 October 1951 and is quoted in the following paragraph:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Big Black River, Mississippi, submitted in House Document No. 72, 73rd Congress, 1st Session, with a view to determining whether the recommendations contained therein should be modified in any way at this time, particularly with reference to the tributaries of the Big Black River."

The second resolution, adopted 31 July 1957, is quoted below:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Big Black River, Mississippi, published in House Document 72, 73rd Congress, with a view to determining whether the existing project should be modified in any way at this time in the interest of flood control and allied purposes."

b. Comprehensive study. Subsequent to the authorizations cited above, a study program of river basins was developed by the Executive Department. The program provides for a group of framework studies covering the Nation (except Alaska) and a group of detailed basin and subbasin comprehensive studies to provide a basis for authorization of specific projects or groups of projects. This program, now approved, includes a basin report on the Big Black River, Mississippi.

2. PURPOSE AND SCOPE

a. The purpose of this study is to establish the best overall plan of development for the water and related land resources of the Big Black River Basin and to determine the best means to accomplish → next page

this development. The aim is to determine both the short and long range needs within the basin for navigation, water supply, flood control, recreation, pollution abatement, hydroelectric power, irrigation, and fish and wildlife conservation; and to formulate a comprehensive plan of improvement to satisfy these needs in a timely and economical manner.

b. To achieve the aim of the study, a coordinated effort among study participants was needed. To accomplish this, a Coordinating Committee was established. The Corps of Engineers acted as chair agency for the Committee, which was composed of representatives of the U. S. Departments of Agriculture; Army; Commerce; Health, Education and Welfare; and Interior; the Federal Power Commission; and the State of Mississippi. The main functions of the Committee were to assure a full and continuing exchange of views during the study; to help resolve study problems as they arose; to advise participating agencies with regard to objectives, task assignments, and schedules; and periodically to review the progress being made. Each of the agencies participating in this investigation has prepared separate reports presenting the results of its studies. The developments recommended in these reports comprise the comprehensive plan of development for the basin. The comprehensive plan is presented in an interagency summary report.

c. This report presents the results of investigations made by the Corps of Engineers in connection with the comprehensive study of the Big Black River Basin.

3. PRIOR REPORTS

a. Reports of 1902 and 1913. The Corps of Engineers investigated the feasibility of navigation improvements on the Big Black River in 1902 and 1913, but submitted unfavorable reports on both occasions.

b. House Document 72, Seventy-third Congress, First Session (1932). This report, dated 1 March 1932, gives the results of studies to determine the feasibility of providing navigation, irrigation, flood protection, and hydroelectric power development in the Big Black River Basin. None of the projects considered in this study were economically justified at that time.

c. Condensed Report on Big Black River and Tributaries, Mississippi, 7 March 1934. This report contains a synopsis of House Document No. 72.

d. Definite project report, 25 January 1937. This report was submitted pursuant to the Flood Control Act of 1936. The plan of improvement for the Big Black River included construction of cutoffs and clearing and snagging of the river channel.

e. Letter Report, Big Black River and Tributaries, 24 June 1939. This report presents a study of the conditions and efficiency of the Big Black River tributary channels in Webster, Choctaw, Montgomery, Carroll, and Attala Counties, and includes a recommendation that improvement of the tributaries be limited to channel clearing and removal of drift, silt, and sand.

f. Preliminary Examination of Bear and Apookta Creeks. In accordance with the provisions contained in Section 11 of the Flood Control Act of 1946, Preliminary Examination Reports were made to determine the needs for flood control on Bear and Apookta Creeks. The preliminary examination of Apookta Creek indicated that no further study was warranted at that time. However, the Bear Creek examination did indicate that additional studies should be made. Following the adoption of the resolutions quoted in paragraph 1, this study was made a part of the Big Black River Basin Study.

4. DESCRIPTION OF BASIN

a. The Big Black River is located entirely in the State of Mississippi. It rises in Webster County and flows about 270 miles in a southwesterly direction to its confluence with the Mississippi River

approximately 27 miles below Vicksburg (see Plate 1). The basin is 155 miles long and averages about 22 miles in width, thus constituting a long narrow basin with a total drainage area of approximately 3,400 square miles. The valley ranges in width from 1/2 to 3-1/2 miles from hill line to hill line, with an average width of approximately 2 miles. Bottom lands along the main stem of the river comprise approximately one-tenth of the total drainage area. Portions of the flood plain of the Big Black River are characterized by two bottoms. The area adjacent to the river is relatively narrow, flat, and wooded, and is subject to overflow approximately two or three times annually. The remaining area between the low-lying bottom land and the hill line rises to a higher elevation, creating a bottom-land shelf which is flooded less frequently and is therefore utilized more intensively for agricultural purposes.

b. The estimated 1965 population of the basin was approximately 235,000. Agriculture is the major industry in the basin. Approximately seventy percent of the total area is devoted to agricultural uses. At present, manufacturing plays a minor role in the economy of the basin. The area is served adequately by a network of railroads, Federal and state highways, and power and telephone lines. Additions to these facilities are being made as rapidly as development in the basin requires.

5. TOPOGRAPHY

The Big Black River Basin lies in the "Hill Section" of Mississippi. The topography is characterized by belted layers of geologic deposits and ranges from rolling to hilly. Land surface elevations vary from about 60 feet, mean sea level, at the confluence of the Big Black and Mississippi Rivers to more than 500 feet, mean sea level, along the eastern rim of the basin. The highest and most rugged terrain is found in the upper reaches of the eastern tributaries of the Big Black River. Strong relief in portions of the basin has caused rapid erosion and the development of gullies in many places throughout the basin.

6. DRAINAGE SYSTEM

The terrain and configuration of the Big Black River Basin are such that no appreciable amount of the total drainage area is controlled by any single tributary. Numerous small tributaries thoroughly dissect both the eastern and western margins of the basin and enter the main channel at fairly even intervals throughout its length. These tributaries, few of which are over twenty miles in length, have their source in the hill section of the basin and carry a rapid runoff from drainage areas which vary from a minimum of 6 to a maximum of 200 square miles.

7. GEOLOGY AND SOILS

The Big Black River Basin is characterized by a belted topography of aligned hills and valleys which parallel the inland border of the Gulf Coastal Plain. This belted topography is a result of the differential erosion of the deltaic deposits exposed in the basin. Sedimentary deposits exhibiting a wide range in geologic age are also found within the basin. Studies of these sediments indicate the accumulation of a seaward thickening sedimentary wedge composed principally of deltaic deposits accumulated upon a basement of older rocks which outcrop in the uplands adjacent to the coastal plain. A recent river alluvium deposit has been developed along the river channel. Below river mile 185, this alluvium varies in thickness from 15 to more than 50 feet. The alluvium consists of a fine grained top stratum of clays and silts and grades downward into the silty sands and sands with clay and silt strata. Above river mile 185, the river channel encounters Tertiary sediments. These sediments are composed of loosely consolidated clays, silts, and sands with scattered thin lenses of sandstone, ironstone, or siliceous siltstones. There are no known geologic conditions which would adversely affect the engineering structures considered in this report and no significant foundation problems are anticipated. (See Appendix G for a more detailed discussion of the geology and soils.)

8. CHANNEL CHARACTERISTICS

The Big Black River channel ranges in width from approximately 90 feet in the headwater section above Kilmichael, Mississippi, to almost 250 feet in the Mississippi River backwater area below Bovina, Mississippi. Channel bottom slopes vary from 2.5 feet per mile above Kilmichael to 1.0 foot per mile below Kilmichael with corresponding low water surface slopes. Bank heights along the river average 15 to 25 feet above the normal low water surface.

9. CLIMATOLOGY

a. Climate. The area in which the Big Black River Basin is located is characterized by a mild climate with normal seasonal temperature variations. Winter temperature readings below zero are uncommon, as are sustained periods of subfreezing weather. Average monthly temperatures range from 50° F. in the winter to 80° F. in the summer. The average annual temperature is 65° F.

b. Precipitation. Rainfall throughout the Big Black River Basin averages 52 inches annually. Monthly rainfall averages range from 2.1 inches in October to 5.6 inches in March, with the period from November to May incurring an average of 5 inches per month. Climatology of the basin is discussed in more detail in Appendix A.

10. RUNOFF AND STREAMFLOW DATA

a. Runoff. Runoff from the area fluctuates considerably. Depending upon antecedent conditions, rainfall intensity, and season of the year, runoff in the Big Black River Drainage area varies from about 10 percent of rainfall in the summer and fall to a maximum of 85 percent during the winter and early spring. Annual runoff from the area averages approximately 17 inches.

b. Streamflow data. Gaging stations along the Big Black River have been maintained at Kilmichael, West, Pickens, and Bovina, Mississippi, since 1936. A fifth gaging station was established at Bentonia,

Mississippi, in 1947. Maximum and minimum stages and discharges for each of the gaging stations are shown in the following table.

TABLE 1
MAXIMUM AND MINIMUM STAGE AND DISCHARGE

Gaging Station 1/	Location (river mile)	Drainage area (sq mi)	Stages Maximum (ft msl)	Stages Minimum (ft msl)	Discharge Maximum (cfs)	Discharge Minimum (cfs)
Kilmichael	248	549	313.8	296.9	37,300	5
West	206	985	273.8	250.1	47,000	21
Pickens	160	1,460	220.0	197.6	49,400	27
Bentonia	106	2,340	161.8	135.7	66,500	39
Bovina	62	2,810	125.5	90.9	63,500	65

1/ Period of record: 19 year record - Bentonia.
30 year record - Kilmichael, West, Pickens, and Bovina.

c. Most of the streams tributary to the Big Black River in the upper half of the basin are perennial. In the lower half of the basin, flow in the tributaries normally stops for some period each year. During dry periods, two-thirds of the flow of the Big Black River is from the upper half of the basin where perennial tributaries are numerous.

d. Flow-duration data shows that 90 percent of the time the flow in the Big Black River at Pickens, Bentonia, and Bovina, Mississippi, equaled or exceeded 85, 130, and 157 cubic feet per second, respectively. Flow-duration data are not available on the upper reaches of the river.

11. ECONOMIC DEVELOPMENT, PRESENT AND PROJECTED

a. General. For the purpose of evaluating the economic potential of the Big Black River Basin, a base study area was established consisting of Montgomery, Webster, Choctaw, Carroll, Holmes, Attala, Madison, Yazoo, Warren, and Claiborne Counties, and the western portion of Hinds County. This area, shown on Plate 1, is the primary

area that would be influenced by the development of water resources within the basin. An economic base study of this area is contained in the "Report of the Economic Base Study for the Pascagoula, Pearl, and Big Black River Basins Study Area." This report was prepared through contract with Michael Baker, Jr., Inc., Consulting Engineers and Planners. Information from this report is summarized in the following paragraph and presented in more detail in Appendix B.

b. Population. The Big Black River Basin Study Area is a sparsely populated area averaging 34 people per square mile. The total population of the area gradually increased until 1940, then began to decrease as agriculture became either mechanized or unprofitable. This trend in population is expected to reverse between 1960 and 1970 when urban growth in Vicksburg and Jackson combine to raise the basin's population. The population is expected to reach a peak of 379,000 by the year 2015. A large percentage of this increase is expected to come from Jackson's future population growth which is forecasted to expand into the Big Black River Basin. While statistically accounted for in the Big Black River Basin, the majority of these people will be employed in the Pearl River Basin. This provides the Big Black River Basin with increased population not related to employment within the basin. Population of the study area for the period from 1870 to 2015 is shown in the table below.

TABLE 2
POPULATION OF BASE STUDY AREA

Year	Population	Year	Population
1870	171,500	1930	274,000
1880	232,200	1940	298,900
1890	243,200	1950	266,300
1900	294,100	1960	241,900
1910	302,800	1980	248,500
1920	254,300	2015	379,000

c. Employment.

(1) The shift to mechanization in farming practices has brought a decrease in the demand for agricultural labor and a resultant decline in total employment. This is reflected in the following table which lists 63 percent of the total employment as agricultural in 1940 as compared to only 27 percent in 1960.

TABLE 3
EMPLOYMENT IN BASE STUDY AREA

Item	1940		1960		1980		2015	
	Number emp.	% of Total	Number emp.	% of Total	Number emp.	% of Total	Number emp.	% of Total
Employment								
Agriculture	63,000	63	20,000	27	9,000	13	6,000	6
Manufacture	6,000	6	11,000	15	15,000	21	31,000	28
Nonagriculture, Nonmanufacture	31,000	31	43,000	58	48,000	66	72,000	66
Total	100,000	100	74,000	100	72,000	100	109,000	100

(2) During this same period, the percentage of employment in manufacturing and nonmanufacturing-nonagriculture groups has almost doubled. These groups show a continued gain as a percentage of the total employment between 1960 and 2015.

d. Income. Personal income in the base study area increased 185 percent from 1940 to 1965 and is expected to double in the 1965 to 2015 period. During this same period the increase in personal income in areas surrounding the study area should be greater. Table 4 shows the median personal income for the base study area, the United States and the tristate area. This tristate area includes the State of Mississippi, 19 counties in Western Alabama and 12 parishes in southeastern Louisiana.

TABLE 4
MEDIAN PERSONAL INCOME

Area	1940	1950	1960	1965	1980	2015
	$	$	$	$	$	$
Base study area	457	840	1,139	1,325	1,731	2,873
Tristate area	701	1,258	1,612	1,817	2,378	4,235
United States	1,288	1,893	2,274	2,497	3,433	6,511

e. Agriculture. Farmland in the Big Black River Basin Study Area during 1960 constituted almost 70 percent of total land area. In terms of acreage harvested, the leading crops in 1960 were corn, cotton, and hay, respectively. Crop production in the future is projected to deemphasize these crops and place more emphasis on food crops. The structure of the agricultural industry within the basin is also changing. Farmers are becoming more specialized and mechanization is increasing rapidly. This has resulted in a projected decrease in the total number of farms within the study area and a corresponding increase in average size of farms.

f. Manufacturing. Industrial employment reported by the "Mississippi Manufacturers Directory" shows that very few water-use industries are currently located within the Big Black River drainage area. Employment in these industries represents a minor percentage of the study area work force and projections indicate little increase by 2015. One-half of the manufacturing employment not related to water-using industries was concentrated in the lumber, wood, and furniture groups. Major employment gains are projected in apparel and nonelectrical machinery. A substantial share of these projected employment gains are attributable to the growth of activity in the Vicksburg Area.

Figure 1
Main Stem Flooding, Big Black River
Crop and Fence Damage

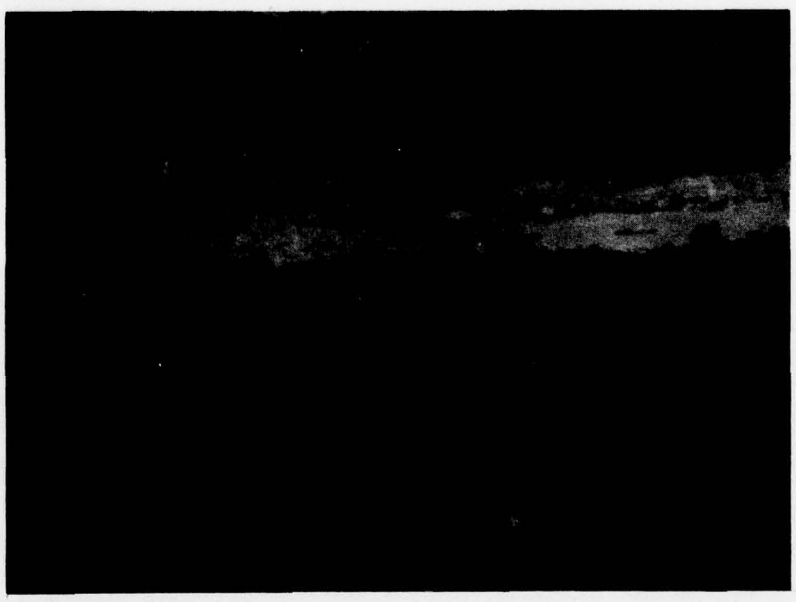

Figure 2
Main Stem Flooding, Big Black River
Crop, Utility, and Rural Property Damage

12. WATER AND RELATED LAND RESOURCE PROBLEMS

a. Flood problems.

(1) Floods occur within the Big Black River Basin frequently, and damages are prevalent throughout the entire basin. Approximately two damaging floods a year occur on the main stem of the river during the crop-growing season. Winter floods generally are not as high as summer floods, but are more frequent and of longer duration. Table 5 shows data on major floods which have occurred within the basin.

TABLE 5
FLOOD DATA

Flood	Gaging Stations							
	Kilmichael, Miss.		West, Miss.		Bentonia, Miss.		Bovina, Miss.	
	Crest elev. (msl)	Freq. (years)	Crest elev. (msl)	Freq. (years)	Crest elev. (msl)	Freq. (years)	Crest elev. (msl)	Freq. (years)
1927	1/	-	-	-	-	-	-	-
1930	-	-	-	-	-	-	-	-
1944	312.5	8	272.7	8	-	-	124.2	7
1946	311.3	2	272.1	6	-	-	124.1	6
1949	313.0	12	273.3	11	160.0	6	124.3	7
1951	314.0	30	273.2	10	161.5	12	124.8	17
1958	311.2	2	270.1	2	160.8	9	124.5	9
1961	310.5	2	273.4	11	161.5	12	124.9	19

1/ no records available.

(2) The Big Black River flood plain is subject to headwater flooding which results from flood plain runoff and drainage from the hill section of the watershed. In addition, the flood plain below mile 62 is subject to backwater flooding from the Mississippi River. Under existing conditions, 590,000 acres are subject to overflow, of which 211,000 acres (46,000 acres cleared) are along the main stem and 279,000 acres (43,000 acres cleared) are in the tributary flood plain.

(3) Agricultural damage to crops, farm buildings, fences, other farm improvements, and local roads constitutes approximately

90 percent of the total flood damages (see Figures 1 and 2). The principal highways and railroads as well as all major communities are above flood level. The timber industry incurs minor losses from flooding, consisting primarily of delays in harvesting with attendant losses in salaries for individuals engaged in this activity.

(4) Under existing conditions, 45,000 acres are inundated annually along the main stem with an average annual flood damage of $236,000. Table 6 summarizes the average annual flood damages in the Big Black River Basin. (See Appendix C.)

TABLE 6
AVERAGE ANNUAL FLOOD DAMAGES

Reach	Limits (miles)	Gage record	Average annual flood damage		
			Crop	Noncrop	Total
			$	$	$
Kilmichael	213-262	1936-1960 1964-1966	37,000	20,000	57,000
West	162-213	1936-1966	37,000	32,000	69,000
Bentonia	92-162	1947-1966	39,000	20,000	59,000
Bovina	0- 92	1936-1966	39,000	12,000	51,000
Total			152,000	84,000	236,000

b. Water supply.

(1) The United States Public Health Service and the Federal Water Pollution Control Administration conducted an investigation to determine the storage and stream flow regulation needed to satisfy present and future requirements for industrial and municipal water supply and the need for low flow augmentation. Ground water investigations, including an inventory of the quality, availability, and safe yield of the ground water aquifers, were made by the United States Geological Survey. The results of these investigations are summarized in the following paragraphs.

(2) Water use in the Big Black River Basin is light, since the region is neither heavily populated nor industrialized. The domestic, municipal, and industrial water is supplied from wells and

a small amount of surface water is used for supplemental irrigation of row crops. The largest amount of water used in the basin by a single municipality in 1960 was 1.0 m.g.d., (million gallons per day) in Winona. The total ground water withdrawal, including water from many unused flowing wells, was about 10 m.g.d. in 1960 and 11 m.g.d. in 1965. It is estimated that the available ground water supply is of sufficient quantity for the towns in the area to double or triple their ground water pumpage. In some areas adjacent to the basin, ground water withdrawal in 1960 was comparatively heavy, with Jackson using 10 m.g.d., Yazoo City using 8 m.g.d., and Kosciusko using 2 m.g.d. Less than 500 acre-feet of water is diverted annually from streams in the basin for supplemental irrigation. Practically all cattle in the basin are watered from either streams or ponds.

(3) Abundant supplies of good quality ground water and surface water are available in the Big Black River Basin. Several geologic aquifer systems underlie the basin, with two or more major aquifers being accessible at most points in the basin. Based on available data of aquifer characteristics and thicknesses, and assuming a drawdown to a depth of 300 feet, ground water availability within the basin is shown on the following table.

TABLE 7
GROUND WATER AVAILABILITY 1/

Locality	Million gallons per day	Locality	Million gallons per day
Benton	25-50	Goodman	25-50
Bentonia	25-50	Jackson	10-15
Bolton	10-15	Kilmichael	10-25
Bovina	10-15	Kosciusko	10-25
Canton	25-50	Maben-Mathiston	10-15
Clinton	10-15	Madison	10-25
Durant	25-50	Pickens	25-50
Edwards	10-15	Port Gibson	10-15
Eupora	10-15	Utica	10-25
Flora	10-25	Vaiden	10-25
French Camp	10-15	West	10-25
Grand Gulf	10-50	Winona	10-15

1/ Availability within 5 miles of the locality.

(4) There will be no need within the study period for additional surface water supply storage because, (1) sufficient ground water is available to serve the projected needs of the basin, and (2) both Jackson and Vicksburg, Mississippi, the major population centers sufficiently near the basin to use its waters, are currently served by sources outside the basin. Prospects are that this will remain true for the next fifty years. (See United States Geological Survey Report, Volume IV, Annex F.)

c. Water quality.

(1) Surface water.

(a) The Big Black River is a stream of good quality water. A small amount of pollution enters the river, and except for isolated areas, is not in sufficient quantity to degrade it. During periods of low stream flow, there are isolated areas where the water quality falls below the desired level for swimming or water contact sports. The controls contemplated in the Federal Water Pollution Control Act and the proposed legislation of the State of Mississippi should help correct the condition in these isolated areas and maintain the good overall quality of the river.

(b) Four tributaries, Hays, Bear, Fourteenmile, and Bakers Creeks, have water quality problems during periods of low stream flow. (See Federal Water Pollution Control Administration Report, Volume IV, Annex E.) These problems result from the discharge of raw municipal waste into the tributaries. These tributaries have low summertime flows and often dry up in their upper reaches. Enforcement of the water quality control standards being developed for the State of Mississippi should help correct these conditions.

(c) Prior to development of any improvements which would impound flows on the main stem or tributaries for water supply or recreational uses, additional sanitary studies would be needed to assure that the water would meet all Public Health Service Standards for water contact sports or domestic use.

(2) Ground water. Initial water quality analyses have shown that ground waters throughout the basin are acceptable for most uses. In isolated areas of the basin, there are indications that certain chemical constituents of the water might exceed the desired level for domestic or irrigational uses. Thus, before large ground water developments are undertaken, detailed water sampling and analysis should be made to determine if treatment of the water will be necessary.

d. Recreation.

(1) The need for recreation development in the Big Black River Basin was determined by the Bureau of Outdoor Recreation as follows: Per capita participation rates for water-oriented recreation were obtained from a sample study by the Bureau of the Census adjusted to the recreation market area. Total participation (expressed in activity occasions) was then determined from the present and projected population of the basin counties and the Standard Metropolitan Statistical Area in the recreation market area.[1/] The demand was further adjusted to reflect the variation in the per capita income of the study area from that of the general section of the country from which the participation rates were derived. Recreation-day is the unit of measurement used to assess recreation demand, and for this study, it was estimated that there would be 1.9 activity occasions for each recreation day on the Corps of Engineers reservoirs.

(2) The activities for which a need was developed were swimming, boating, camping, picnicking, and other activities (including nature study, hiking, and incidental fishing, but excluding sightseeing). A comparison of the demand for recreation and the supply of recreation resources was made and shows a large deficiency of recreation facilities at the present, and an increasing deficiency throughout the study period. The estimated unsatisfied recreation demand for the basin in 1980 and 2015 expressed in annual recreation days is 3.2 and 11.5 million, respectively.

e. Fish and wildlife. The Bureau of Sport Fisheries and Wildlife

1/ An activity occasion is the participation by one person in one recreational activity during one day.

made an appraisal of the fish and wildlife resources of the Big Black River Basin to determine the need for additional fishing and hunting opportunities. Per capita demand factors were derived from data extracted from the "1960 National Fishing and Hunting Survey." Total demand for the basin (expressed in man-days of activity) was determined from the population age group twelve years of age and older. The net existing and projected need for fishing and hunting in the basin was determined by comparing demand with the supply of available resources. The following table shows the need throughout the study period. (See Bureau of Sport Fisheries and Wildlife Report, Volume IV, Annex D.)

TABLE 8
FISHING AND HUNTING NEEDS

Resource	1980	2015
Fishing need (man-days)	0	35,000
Hunting need (man-days)	18,000	122,000

f. Navigation. There are no records of any considerable amount of commercial navigation on the Big Black River. Even before the development of railroad and highway transportation, few cargo boats used the waterway. At present, there are few commodities which might offer commerce to a navigation project and no prospect of additional need for navigation in the basin. There are commodities in the Jackson, Mississippi, area which are adaptable to barge transportation. Present shipping in and out of Jackson is done entirely by rail and highway transportation. Waterborne shipment into the Jackson area could be provided by either a navigable channel on the Pearl River, or a waterway traversing the Big Black River Basin which would link Jackson to the Mississippi River.

g. Power.

(1) The Federal Power Commission developed the present and expected future power requirements in the Big Black River Basin. The Federal Power Commission Study Area K, which comprises essentially

the area served by the Southwest Power Pool and associated systems, has been designated as the power market area for hydroelectric power from the Big Black River Basin.

(2) An analysis of the existing and future expected power supply in "Study Area K" shows a surplus above reserves for both 1964 and 1970. By 1980, a need will develop for an additional capacity of 12,763 megawatts, of which 4,240 could be hydroelectric. The amount of hydroelectric power which could be used will increase to 29,640 megawatts by the year 2020. If economically feasible, a portion of this need could be met by developing hydroelectric power projects within the Big Black River Basin. Since determination of the potential hydroelectric power in the basin under modern day criteria is dependent on plan formulation studies involving other project functions, the only purpose here is to define the amount of hydroelectric capacity that could be utilized in the future, if available. (See Federal Power Commission Report, Volume V, Annex H.)

13. IMPROVEMENTS DESIRED

Public hearings were held in Winona and Canton, Mississippi, on the 4th and 5th of November 1964, respectively. At these hearings, the objective and plan of study for the Big Black River Basin was presented, and local interests were requested to identify water resource problems within the basin. Local people expressed a desire for flood control works and improved drainage systems for their agricultural lands, but were not in favor of any improvements which would take cropland out of production. Local spokesmen favored the construction of impoundments in the wooded hill sections of the tributary watersheds, with some type of main stem channel work (cleanout, enlargement, or realignment). Several parties expressed a desire for a main stem reservoir above West, Mississippi, to protect the agricultural bottom land along the main stem below West, Mississippi. Since these hearings, the construction of a waterway linking Jackson to the Mississippi River was proposed and the Mississippi Legislature passed a bill creating a Waterway Commission in Hinds, Madison, and Warren Counties to study the feasibility of the waterway.

14. EXISTING AND AUTHORIZED IMPROVEMENTS

a. Corps of Engineers.

(1) Flood control. Flood Control Acts of 1936 and 1937 authorized the Corps of Engineers to construct channel improvements on the Big Black River and certain tributaries. This work consisted of constructing 43 cutoffs, channel clearing and snagging, removal of log jams along the main stem, and construction of channel clearing on certain tributaries of the Big Black River in Attala, Carroll, Montgomery, Choctaw, and Webster Counties. The work on the main stem of the Big Black River was completed in 1939 and the work on the tributaries was completed in 1941. The total cost of this work was $1,020,000.

(2) Navigation. The original project for the Big Black River, adopted in 1881, provided for high-water navigation to Cox's Ferry (mile 102) by removal of wrecks, snags, etc., from the channel. Snagging operations actually started in 1884 but were suspended in 1894, pending removal of low, fixed bridges. Local interests subsequently decided the bridges were of more value than navigation and further work to improve navigation was discontinued.

b. Other Federal and non-Federal agencies.

(1) Department of Agriculture. The first Soil Conservation District in the Big Black River Basin was organized in Claiborne County in December 1938. Since that date, Districts have been organized in all of the other counties which are entirely or partially within the basin. All of the Districts are actively engaged in carrying out soil and water conservation programs with individual farmers.

(a) To date, detail soil surveys have been completed on 69 percent of the agricultural land. Farm plans have been prepared for 41 percent of the farms comprising 40 percent of the agricultural land.

(b) Since 1957, seven watershed districts have been organized and work plans approved. In these watersheds, 21 flood-

water retarding structures, 61 miles of channel improvement, and 96 grade control structures have been completed. (See Department of Agriculture Report, Volume II, Annex A.)

(2) Drainage districts. Nine drainage districts were organized in the basin between 1911 and 1924. By June 1939, these districts had constructed approximately 70.5 miles of drainage channels. Most of these districts are now dormant and there is little or no channel construction or maintenance underway.

15. IMPROVEMENT PLANS CONSIDERED

a. Planning considerations. In formulating a plan of improvement to satisfy the water and related land resource needs of the Big Black River Basin, various improvement measures were considered. These measures would provide: (1) flood control; (2) hydroelectric power; (3) navigation facilities; (4) outdoor recreation; and (5) fish and wildlife protection and development.

b. Planning objectives. In the development of projects to meet the needs of the basin, the following objectives should be employed to the fullest extent practicable: (1) be compatible with the existing water uses; (2) be the most economical means of accomplishing the purpose or purposes; (3) provide maximum excess of benefits over costs; and (4) be capable of further expansion.

c. Plans considered.

(1) General.

(a) The analysis of the basin's water and related land resource problems and needs indicates immediate and long-range needs for flood control, power, recreation, and fish and wildlife enhancement. There is no existing need for navigation within the basin proper; however, a need exists for a navigable waterway into the Jackson area which might be satisfied by a channel traversing (crossing) the Big Black River Basin. To assure that these needs are met in an orderly and timely manner, projects which would satisfy the needs developing by the year 2015 were considered. The projects needed by 1980 were studied in detail and those needed beyond this date were

identified only. Investigation of the projects needed beyond 1980 will be required as needs develop.

(b) In developing a plan of improvement, five types of improvements were considered: (1) reservoirs; (2) improvement of main stem channel; (3) construction of levees; (4) nonstructural measures; and (5) navigation channels.

(2) Main stem reservoirs.

(a) An investigation was made of the Big Black River to locate potential flood control reservoir sites along the main stem. Three possible sites were located: (1) one upstream from West, Mississippi; (2) one in the vicinity of Durant, Mississippi; and (3) another near Edwards, Mississippi. (See Plate 2 for the location of these sites.) A reservoir at the West site would control 30 percent of the total drainage area of the basin. However, the numerous tributaries entering the river below the dam would limit potential flood control benefits. Extensive relocations would be necessary for the main line Illinois Central and Columbus to Greenville Railroads, U. S. Highways 51 and 82, and Interstate Highway 55. The valley in this area is comparatively wide, requiring a long expensive dam. The site offers limited potential for hydroelectric power development. The reservoir would provide recreational areas; however, the principal demand for recreation is concentrated in the lower part of the basin. A reservoir at the Durant site would inundate the main line Illinois Central Railroad, U. S. Highway 51 and portions of Interstate Highway 55, and require relocation of the town of West, Mississippi. The impoundment would inundate productive cropland along the main stem of the river and up a number of the tributaries. As at the West site, there are numerous tributaries entering the river below the dam which would reduce the flood control effect of the reservoir. The principal benefit derived from this reservoir would be attributed to recreation. Because of the high cost of a dam at the West or Durant sites, extensive costs and transportation disruption involved in the relocation of major highways, railroads and county road systems, cost and impact of relocating the community of West, Mississippi, and the limited flood control benefits which would be realized, the Durant and West

sites were eliminated from further consideration.

(b) The Edwards site offers the best potential for the development of a main stem reservoir. The river valley at this point narrows to 6,500 feet in width and provides an excellent damsite. The impoundment behind a dam at this site could extend upstream approximately 60 miles, requiring alteration of five miles of major highways and six miles of railroad. A dam at this site would control the runoff from 80 percent of the basin's drainage area. The availability of water and the head which would be provided (approximately 50 feet), offers the best potential within the basin for the development of hydroelectric power. The reservoir would be located adjacent to the urban areas of Vicksburg and Jackson, Mississippi, where the principal recreational demand in the basin is expected to develop. A reservoir at this location would also be a source of water supply if a need should develop. A reservoir at this site was investigated as a multipurpose project for flood control, hydroelectric power, and recreation.

(3) Tributary reservoirs. An alternative to providing flood protection by controlling the main stem flows is to control the flows of the tributaries. An investigation was made to locate possible reservoir sites on the tributaries. Seventeen potential sites were established. These sites are shown on Plate 3. Dams constructed at these sites would control drainage areas varying from 8 square miles to 150 square miles. No single dam could control a large enough percentage of the total flow of the river to provide a significant amount of flood protection along the main stem. Collectively, they would control 940 square miles of drainage area or 28 percent of the total Big Black River Basin. When considered as a unit, these dams would have the potential of providing enough flood protection along the main stem to warrant further consideration. These 17 reservoirs would also provide water-based recreation sites well distributed over the basin. Because of their potential for providing main stem flood protection and their excellent recreational potential, a detailed

analysis was made of these 17 reservoirs. When evaluating the flood control benefits, the 17 reservoirs were considered as a unit. Consideration was also given in evaluating flood control benefits to the effect of the 117 floodwater retarding structures proposed by the Soil Conservation Service on tributaries not controlled by the reservoirs.

(4) Main stem channel improvement plans.

(a) Enlargement and other improvements of the Big Black River channel were investigated as a means of providing flood protection along the main stem of the river. Five channel capacities were initially considered. They were: (1) enlargement of the existing channel to a capacity sufficient to contain the 3-year (May-October) frequency flows within banks (channel improvement 3-year frequency); (2) enlargement of the channel to a capacity sufficient to contain the 1-year (May-October) frequency flows within banks (channel improvement 1-year frequency); (3) enlargement of the channel to a capacity which, in combination with the 17 tributary reservoirs, would contain the 3-year frequency flows within banks; (4) the maximum channel enlargement and improvement which could be undertaken without extensive relocations; and (5) clearing and snagging the existing channel. The May-October period was used because this period of the year covers the normal agricultural growing season when crop damages are at a maximum. (See Plate 4 for the limits of the channel work and Plates 5 and 6 for the design flow line.)

(b) Preliminary investigations indicated that none of the five plans considered would be economically justified. The smallest channel enlargement plan, and the clearing and snagging plans listed as Plans 4 and 5, did not increase the capacity of the channel sufficiently to produce any significant flood control benefits. The other plans lowered flood stages but with a major increase in construction costs, due primarily to the large quantity of channel excavation and extensive relocations required for the plans. These relocations include extension and alteration to 20 highway bridges, 2 of which are interstate, 5 railroad bridges, and a number of pipelines. The two plans which would be the most effective in providing flood control and had the best benefit-to-cost

ratio in the preliminary evaluation were selected for detailed study. These plans are the channel improvement, 3-year frequency plan, and the channel improvement, one-year frequency plan, listed as Plans 1 and 2 above. The effect of the floodwater retarding structures being proposed by the Soil Conservation Service for construction in the hill areas of the tributaries were considered in evaluating benefits for both of these plans. Plate 4 shows the location of the Soil Conservation Service structures.

(5) Local protection projects. An investigation was made of the bottom lands along the Big Black River to locate areas which might be protected by levees. Seventeen sites were found at which construction of loop levees tieing to the hills would protect areas ranging in size from 1,000 to 2,000 acres (see Plate 7). The levees range in height from 12 to 20 feet and in length from 4 to 9 miles. Interior drainage would be discharged through floodgates in the levees. At 15 of these sites the areas required to impound interior runoff during high stages on the Big Black River would include a large percentage of the area behind the levees. Expensive pumping plants would be necessary to reduce this required sump area. For these reasons, these 15 sites were eliminated from further consideration. Two of the sites, one near the mouth of Apookta Creek and the other near Goodman, Mississippi, appeared to have suitable sump areas and were analyzed in detail.

(6) Nonstructural flood protection measures. Nonstructural alternatives for reducing flood damages in the Big Black River Basin include public information and education on the hazards of flooding to the end that management programs for controlling and regulating the economic use of flood plains may be more effectively implemented. Flood plain information reports prepared by the Corps of Engineers would disseminate the necessary information on local flood problems to municipalities or counties throughout the basin. The Corps of Engineers provides limited technical advice and assistance to agencies of Federal, State, and local government and certain private groups in interpreting flood information and planning measures for reducing flood damages. The continuing improvement of the flood forecasting and flood warning services of the U. S. Weather Bureau is also important in any program of flood damage prevention.

(7) Navigation.

(a) Local interests have proposed that consideration be given to providing a navigable waterway into Jackson, Mississippi, by construction of a waterway traversing Warren and Hinds Counties, Mississippi, to connect the Pearl River with the Mississippi River. In addition to being a navigable waterway, other features that could be included in such a canal are flood control, irrigation, and recreation. To coordinate and develop studies for such a waterway, the State of Mississippi Legislature created the West-Central Mississippi Waterway Commission (House Bill Number 736, regular session, 1966). The principal duties of this commission are to coordinate the efforts necessary to develop and cause to come into being a multiple-purpose waterway traversing Warren and Hinds Counties with a supply channel traversing Madison County to a point on the Pearl River or to reservoirs located thereon. As such a waterway would traverse the Big Black River Basin, a feasibility investigation was made. Three possible routes were identified and are shown on Plate 8. All of these routes would require an expensive system of locks and dams to overcome the approximate 230 feet elevation differential between Jackson and the Mississippi River. Any route would have to cross the Big Black River by means of a flume or other structural measures and would require extensive relocations. Preliminary analysis indicates that such a canal would cost on the order of $300,000,000. Benefits that might be realized include flood control, irrigation, and recreation. However, the principal benefit resulting from such a plan would be the transportation savings gained by shipping via the waterway between Jackson and the Mississippi River, as opposed to shipping the 40 mile distance over land by truck or rail. Prospective tonnages and savings, as well as other benefits resulting from such a project, were found to be insufficient for a project of this magnitude to approach economic justification at this time. Therefore, a waterway traversing the Big Black River Basin linking Jackson to the Mississippi River was eliminated from further consideration in this report.

(b) In connection with the Pearl River Comprehensive River Basin study, which is underway and scheduled for completion in

1969, consideration is being given to canalization of the Pearl River from the Gulf of Mexico to Jackson, Mississippi, to meet the need for waterborne transportation into the Jackson area. If a navigation project is not developed on the Pearl River, future reinvestigation of a project linking Jackson, Mississippi, with the Mississippi River should be considered.

16. ESTIMATE OF FIRST COSTS

Table 9 presents a summary of estimates of first costs for the plans for which detailed analyses were made. These plans include: (a) Edwards main stem reservoir; (b) tributary reservoirs; (c) main stem channel improvement (3-year frequency and 1-year frequency); and (d) local protection projects (Goodman and Apookta loop levees). Appendix F gives additional information on cost estimates and presents a detailed breakdown of the cost for the plans listed on Table 9. The construction costs are based on comparable work in the Vicksburg District.

17. ESTIMATES OF ANNUAL CHARGES

Table 10 presents a summary of estimates of annual charges, including estimates of annual operation and maintenance costs for the plans shown on Table 9. Interest and amortization are based on the current interest rate of 3-1/4 percent. The reservoirs were evaluated on a 100-year life and the other plans on a 50-year life. Operation and maintenance costs are based on costs of similar works in the Vicksburg District.

18. ESTIMATE OF BENEFITS

a. Flood control benefits. Flood control benefits for each plan considered for the Big Black River flood plain consist of crop damages prevented, noncrop damages prevented, and increases in net returns to agricultural lands. Crop damages and damages prevented were estimated for the period 1941-1965 taking into consideration acres flooded, date of floods, production costs, returns to lands, and crop distribution. Noncrop stage damage curves were developed from an inventory of buildings and other real property improvements in the flood plain. These were used for the purpose of estimating noncrop damages and damages prevented. Average annual damages prevented

TABLE 9

ESTIMATED FIRST COSTS FOR PLANS CONSIDERED 1/

(1967 PRICE LEVEL)

Item	PLANS					
	Edwards main stem reservoir 2/	Tributary reservoirs 3/	Main stem channel improvement 3 yr. freq. 4/	Main stem channel improvement 1 yr. freq. 5/	Local protection projects: Goodman loop levee 6/	Local protection projects: Apookta loop levee 7/
	$	$	$	$	$	$
Lands	17,210,000	11,100,000	3,340,000	2,480,000	55,000	44,000
Dams	13,600,000	10,520,000	-	-	-	-
Power plant	10,100,000	-	-	-	-	-
Channels	-	-	37,420,000	14,850,000	76,000	50,000
Levee	-	-	-	-	434,000	306,000
Drainage structure	-	-	-	-	245,000	240,000
Relocations	32,610,000	4,100,000	13,050,000	8,990,000	9,000	-
Rec. fac.	7,400,000	2,780,000	-	-	-	-
Eng. & design	6,370,000	1,740,000	3,630,000	1,730,000	57,000	48,000
Supv. & adm.	5,600,000	1,530,000	3,130,000	1,570,000	61,000	48,000
Total first cost	92,890,000	31,770,000	60,570,000	29,620,000	937,000	736,000

1/ Costs include approximately 20% contingencies.
2/ Main stem reservoir for flood control, recreation, and power.
3/ 17 tributary reservoirs for flood control and recreation.
4/ 250 miles of main stem channel enlargement varying from 60 to 200 feet.
5/ 250 miles of main stem channel enlargement varying from 30 to 60 feet.
6/ Loop levee paralleling main stem channel giving flood protection to approximately 2,000 acres.
7/ Loop levee paralleling main stem channel giving flood protection to approximately 1,000 acres.

TABLE 10

ESTIMATED ANNUAL CHARGES FOR PLANS CONSIDERED[1/]

(1967 price level)

Item	Plans				Local protection projects	
	Edwards main stem reservoir[2/]	Tributary reservoirs[3/]	Main stem channel improvement 3-yr. freq.[4/]	Main stem channel improvement 1-yr. freq.[5/]	Goodman loop levee[6/]	Apookta loop levee[7/]
	$	$	$	$	$	$
Interest	3,264,000	1,083,000	2,064,000	1,010,000	30,500	23,900
Amortization	139,000	46,000	523,000	256,000	7,700	6,100
Loss of net return on lands	284,000	185,000	48,000	33,000	700	600
Fish and wildlife losses	69,000	36,000	139,000	55,000	1,000	400
Operation and maintenance:						
Dams	200,000	95,000	-	-	-	-
Channels	-	-	200,000	200,000	-	-
Levees	-	-	-	-	1,000	700
Ditches	-	-	-	-	800	800
Rec. facilities	843,000	150,000	-	-	-	-
Drainage structures	-	-	-	-	500	500
Major replacements	30,000	-	-	-	200	200
Total annual charge	4,829,000	1,595,000	2,994,000	1,554,000	42,400	33,200

1/ Reservoirs, 100-yr. life; channel improvement and levees, 50-yr. life.
2/ Main stem reservoir for flood control, recreation, and power.
3/ 17 tributary reservoirs for flood control and recreation.
4/ 250 miles of main stem channel enlargement varying from 60 to 200 feet.
5/ 250 miles of main stem channel enlargement varying from 30 to 60 feet.
6/ Loop levee paralleling main stem channel giving flood protection to approximately 2000 acres.
7/ Loop levee paralleling main stem channel giving flood protection to approximately 1000 acres.

were computed by using flood records for the period 1941-1965. Increase in net returns to agricultural lands were based on the difference between projected net returns to lands under existing conditions and the projected net returns to land under flood-free conditions. Net returns to land receiving less than full flood protection were adjusted downward to reflect the amount of protection provided. (See Appendix C for a more detailed discussion of flood control benefits.)

b. Recreation benefits.

(1) General recreation. The recreational potential of the reservoirs was computed using "mix" factors developed by the Bureau of Outdoor Recreation and adjusted to omit sightseeing. The Bureau developed these factors from the Outdoor Recreation Resources Review Commission's participation rates for the Census South. The factors were applied to the water acreages of the reservoirs to obtain their capacities for each recreational activity considered. The value for a recreation day at a reservoir was established on the basis of: (1) the physical and aesthetic characteristics of the water areas and the adjacent lands; (2) the variety of recreational opportunities which would be provided; (3) availability of recreational resources to urban populations; (4) quality of the recreational facilities; and (5) need for recreational development within the basin. Considering these factors, a unit value of $0.75 per recreation day was assigned to the tributary reservoir projects and a value of $1.25 to the Edwards Reservoir. (Appendix E contains a detailed discussion of recreation benefits.)

(2) Fish and wildlife. According to "Mississippi's Outdoor Recreation Plan" dated October 1966, the residents of the State prefer fishing to all other outdoor recreational activities except pleasure driving and sightseeing. Early usage of the Corps of Engineers reservoirs would be assured even though the existing total supply of fishing water is adequate for the present demand. The reservoirs would offer a more convenient fishing opportunity to the basin residents than presently exists. An increased need for fishing water will develop with the increase in the population of the basin.

c. Economic development effects. All the counties in the study area except Hinds and Warren are eligible for assistance under the Public Works and Economic Development Act of 1965. Senate Document 97, Eighty-seventh Congress, provides that in designated areas the "project benefits shall be considered as increased by the value of the labor and other resources required for project construction and expected to be used in project operation, project maintenance, and added area employment during the life of the project, to the extent that such labor and other resources would, in the absence of the project, be unutilized or underutilized." Economic development benefits were estimated by using construction contract expenditure and operation and maintenance expenditure for local labor expected to come from unemployed or underemployed labor in those counties designated as eligible by the Economic Development Administration. The percentage of contract expenditure for local labor as determined from the study was applied feature by feature to the estimated cost of each of the improvement plans. Local unemployed labor averaged 18 percent of the total cost. For project operation and maintenance, local unemployed labor averaged approximately 85 percent of the total operation and maintenance cost. It is considered that these workers would be recruited from 18 counties in proximity to the construction areas. There were over 1,500 male jobseekers registered with the Mississippi State Employment Service in those counties as of December 1966. (Applicants in agricultural and domestic service occupations excluded.) This number would be more than sufficient to supply the local labor estimated to come from the local unemployed or underemployed. Economic development benefits are carried as a separate item in this report for ready identification. (See Appendix D for detailed discussion.) A summary of the benefits for the plans considered is shown on Table 11.

19. ECONOMIC ANALYSIS

A summary of the economic analysis is shown in Table 12, and includes a comparison of first costs, annual charges, annual benefits, benefit-to-cost ratios for each of the plans considered, and the incremental benefit-to-cost ratios for each of the project purposes included in the multipurpose projects. The first cost of these plans

TABLE 11
SUMMARY OF BENEFITS FOR PLANS CONSIDERED 1/

Benefits	PLANS								
	Edwards 2/ main stem reservoir	Tributary 3/ reservoirs	Tributary 4/ reservoirs with SCS structures in place	Main stem 5/ channel improvement 3 yr. freq.	Main stem channel improvement 3 yr. freq. with SCS structures in place 6/	Main stem 7/ channel improvement 1 yr. freq.	Main stem channel improvement 1 yr. freq. with SCS structures in place 6/	Local protection project	
								Goodman loop levee 8/	Apookta loop levee 9/
	$	$	$	$	$	$	$	$	$
Flood damages prevented	22,000	82,000	79,000	187,000	179,000	119,000	105,000	4,500	2,800
Increases in net return to lands	145,000	432,000	319,000	1,153,000	1,037,000	486,000	690,000	31,000	20,000
Recreation	5,630,000	1,780,000	1,780,000	-	-	-	-	-	-
Fish and wildlife	185,000	45,000	45,000	-	-	-	-	-	-
Power	540,000	-	-	-	-	-	-	-	-
Economic development	460,000	125,000	125,000	348,000	348,000	175,000	175,000	5,000	4,100
Total benefits	6,982,000	2,464,000	2,348,000	1,688,000	1,564,000	780,000	970,000	40,500	26,900

1/ Reservoirs - 100- year life; channel improvement and levees - 50-year life.

2/ Main stem reservoir for flood control, recreation, and power.

3/ 17 tributary reservoirs for flood control and recreation.

4/ Floodwater retarding structures studied by Soil Conservation Service assumed in place on the tributaries not controlled by tributary reservoirs. Benefits for these structures are not included.

5/ 250 miles of main stem channel enlargement varying from 60 to 200 feet.

6/ All floodwater retarding structures studied by SCS assumed to be in place. Benefits for these structures are not included.

7/ 250 miles of main stem channel enlargement varying from 30 to 60 feet.

8/ Loop levee paralleling main stem channel giving flood protection to approximately 2,000 acres.

9/ Loop levee paralleling main stem channel giving flood protection to approximately 1,000 acres.

TABLE 12

SUMMARY OF ECONOMIC ANALYSIS FOR PLANS CONSIDERED[1]

Feature	Plans								
	Edwards[2] main stem reservoir	Tributary reservoirs[3]	Tributary[4] reservoirs with SCS structures in place	Main stem[5] channel improvement 3 yr. freq.	Main stem[6] channel improvement 3 yr. freq. with SCS structures in place	Main stem[7] channel improvement 1 yr. freq.	Main stem[6] channel improvement 1 yr. freq. with SCS structures in place	Local protection project: Goodman[8] loop levee	Local protection project: Apookta[9] loop levee
	$	$	$	$	$	$	$	$	$
First cost	92,890,000	31,770,000	31,770,000	60,570,000	60,570,000	29,620,000	29,620,000	937,000	736,000
Annual charges	4,829,000	1,595,000	1,595,000	2,974,000	2,974,000	1,554,000	1,554,000	42,400	33,200
Annual benefits	6,982,000	2,464,000	2,348,000	1,688,000	1,564,000	780,000	970,000	40,500	26,900
Benefit-cost ratio	1.4	1.5	1.5	0.6	0.5	0.5	0.6	0.96	0.8
Incremental B/C ratios[10]									
Flood control	0.5	0.6	0.5	0.6	0.5	0.5	0.6	0.96	0.8
Recreation	1.9	2.8	2.8	-	-	-	-	-	-
Power	0.6	-	-	-	-	-	-	-	-

1/ Reservoirs - 100-year life; channel improvement and levees - 50-year life.

2/ Main stem reservoir for flood control, recreation, and power.

3/ 17 tributary reservoirs for flood control and recreation.

4/ Floodwater retarding structures studied by the Soil Conservation Service assumed in place on the tributaries not controlled by tributary reservoirs. Benefits for these structures are not included.

5/ 250 miles of main stem channel enlargement varying from 60 to 200 feet.

6/ All floodwater retarding structures studied by SCS assumed to be in place. Benefits for these structures are not included.

7/ 250 miles of main stem channel enlargement varying from 30 to 60 feet.

8/ Loop levee paralleling main stem channel giving flood protection to approximately 2,000 acres.

9/ Loop levee paralleling main stem channel giving flood protection to approximately 1,000 acres.

10/ The incremental benefit-to-cost ratios indicate that (a) flood control is not economically feasible as a project purpose in the two multipurpose projects; (b) hydroelectric power is not feasible in the Edwards main stem reservoir project; and (c) recreation is feasible as a purpose in both of the multipurpose projects. The favorable benefit-to-cost ratios of the Edwards reservoir project and the tributary reservoirs project considered with and without SCS structures in place are due to the large amount of recreation benefits accruing to these projects.

ranges from approximately $750,000 to $90,000,000. The benefit-to-cost ratios vary from 0.5 to 1.5. The two multipurpose projects, Edwards main stem reservoir and the tributary reservoirs, were found to be economically feasible. However, when each project purpose was considered individually, flood control and hydroelectric power were not economically justified. The favorable benefit-to-cost ratios resulted because of the significant amount of recreation benefits which could be realized by the construction of these two reservoir projects.

20. COST ALLOCATION

Table 13 shows the results of the allocation of cost to each project purpose for the Edwards reservoir and the 17 tributary reservoirs. These allocations were made using the separable costs remaining benefits method. (See Appendix F for detailed cost allocations.)

21. PROJECT FORMULATION

a. Main stem reservoirs. The reservoir site at Edwards, Mississippi (see Plate 2) was evaluated as a multiple-purpose project to include flood control, hydroelectric power, and recreation. A one hundred year project life was used in the analysis and a benefit-to-cost ratio of 1.4 to 1 was determined. Flood control benefits were evaluated in accordance with procedures outlined in paragraph 18a. This reservoir would control 80 percent of the drainage area of the Big Black River Basin. It would be located in the lower one-quarter of the basin, 17 miles above the influence of the Mississippi River backwater. This location (low in the basin), flooding from the Mississippi River backwater, and flooding from tributaries entering the river below the dam, combine to materially reduce the potential flood control benefits. In addition, the reservoir would inundate agriculturally productive bottom land adjacent to the river for 60 miles above the dam. The flood control benefits were approximately 3 percent of the total project benefits. The total allocation for the reservoir showed that flood control as a project purpose has an incremental benefit-to-cost ratio of 0.5 to 1 and thus would not be

TABLE 13
RESULTS OF COST ALLOCATIONS

Item	Edwards Main Stem Reservoir			Tributary Reservoirs		Trib. Res. with SCS structures in place 1/	
	Flood control	Power	Recreation	Flood control	Recreation	Flood control	Recreation
	$	$	$	$	$	$	$
First cost	13,099,000	24,433,000	55,368,000	20,142,000	11,628,000	20,142,000	11,628,000
Annual charges	571,000	1,116,000	3,147,000	908,000	687,000	908,000	687,000
Benefits	285,000	709,000	5,988,000	552,000	1,912,000	436,000	1,912,000
Benefit-to-cost ratio	0.5	0.6	1.9	0.6	2.8	0.5	2.8

economically feasible. Hydroelectric power was evaluated using the screening criteria developed by the Federal Power Commission for hydroelectric power development in comprehensive basin studies. The available water and head at this location would sustain a hydroelectric power installation of approximately 28,000 kilowatts. Power was found to cost $1,116,000 annually and yield a benefit of $709,000. The incremental benefit-to-cost ratio for hydroelectric power is 0.6 to 1. Recreation benefits were determined in accordance with the provisions of paragraph 18b. Approximately $5,988,000 of recreation benefits would be realized annually from a reservoir at this site. Incrementally, recreation was found to have a benefit-to-cost ratio of 1.9 to 1. Since recreation was the only project purpose found economically justified, no further consideration was given to the development of a multipurpose project at this site. A recreation project at this location would be economically justified and would provide sufficient recreation opportunities to satisfy 100 percent of the basin's 1980 needs for recreation and a large portion of the projected needs. However, since the immediate impact of a reservoir at this site is the inundation of the productive farmlands above the reservoir, the people in the basin have indicated that they are not in favor of such a project. In addition, Public Law 89-72 does not permit the construction by Federal interests of single-purpose recreation projects.

b. Tributary reservoirs. The system of tributary reservoirs was evaluated as a unit for flood control and recreational purposes. A 100-year project life was used in the analysis and the benefit-to-cost ratio was 1.5 to 1. Based on cost allocation (Table 13), flood control incrementally has a benefit-to-cost ratio of 0.6 to 1. This low benefit-to-cost ratio is accounted for in part by the fact that the reservoirs would control only 28 percent of the basin's drainage area and would inundate valuable farmlands along the tributaries on which the dams would be located. These reservoirs would take out of production approximately 35,000 acres of farmland along the tributaries to provide flood protection to 45,000 acres along the main

stem. This is contradictory to the purpose of flood control and to the desires of the local people. As a project purpose, recreation has an incremental benefit-to-cost ratio of 2.8 to 1. However, as is the case with the main stem reservoirs, there is no local support for tributary recreational reservoirs, and Federal law does not permit construction of such projects at the present time by Federal interests.

c. Main stem channel improvement. Detailed engineering and economic studies were made for two channel improvement plans. One plan would contain the 3-year-frequency flow within banks and the other would control the 1-year-frequency flow. Both plans were analyzed using an economic life of 50 years. The 3-year-frequency improvement plan would benefit approximately 125,000 acres along the main stem of the river. Flood damages prevented and returns from more intensive farming practices were $1,688,000. The annual cost of this plan is $2,974,000, giving a benefit-to-cost ratio of 0.6 to 1. The 1-year-frequency channel would benefit 112,000 acres. The annual costs and benefits were $1,554,000 and $780,000, respectively, with a benefit-to-cost ratio of 0.5 to 1. There would be only a minor change in benefits to the channel plans evaluated with the Soil Conservation Service's proposed floodwater retarding structures in place. Since both of these channel enlargement plans, as well as those eliminated during preliminary investigations, were considerably lacking in economic justification, enlargement of the main stem of the Big Black River would not be a feasible method of providing flood protection at this time.

d. Local protection projects. The Goodman and Apookta loop levees, the two levee sites considered feasible from an engineering standpoint, would protect localized areas of approximately 2,100 and 1,300 acres, respectively, along the main stem of the river. Protection would be provided to the bottom lands which, if protected, would be cultivated. Since the basin is primarily an agricultural area and is neither heavily populated nor industrialized, the primary use of the area protected by the loop levees would be for agricultural

production. However, since these sites provided adequate sump areas and a large percentage of the land behind the levees would be protected, they were investigated to determine their economic feasibility. Both of the levees were analyzed assuming a project life of 50 years. The benefit-to-cost ratio for the Goodman loop levee is 0.96 to 1, and for the Apookta loop levee the benefit-to-cost ratio is 0.8 to 1. No further consideration was given to the Apookta loop levee because of its lack of economic justification. The site near Goodman, Mississippi, has a benefit-to-cost ratio approximating unity. This benefit-to-cost ratio would be reduced if economic development benefits were not included. Economic development benefits resulting from a project of this size would not be sufficient to stimulate the economy of the area and are not considered a sound basis for recommending construction of a project. No further consideration was given to developing local levee protection projects because the overall development of the basin would not be added, and none of the sites are economically justified at this time.

22. COORDINATION WITH OTHER AGENCIES

a. General.

(1) The study of the Big Black River Basin, the preparation of this report, and the preparation of the interagency summary report have been fully coordinated with other Federal and non-Federal agencies. Prior to the initiation of this study a coordinating committee was established composed of representatives from: (1) the State of Mississippi; (2) the Department of Agriculture; (3) the Department of the Army; (4) the Department of Commerce; (5) the Department of Health, Education, and Welfare; (6) the Department of Interior; and (7) the Federal Power Commission. The functions of this committee were as follows: (1) to assure a continuing exchange of views during the study; (2) to help resolve study problems as they arose; (3) to advise participating agencies with regard to objectives, task assignments, and schedules; and (4) periodically to review the progress being made.

Throughout the course of this study, coordinating committee meetings were held as needed.

(2) Copies of this report were furnished to cooperating agencies at the field level for their review.

b. State of Mississippi. The State of Mississippi participated in the study by preparing a report entitled "Role of the State of Mississippi in the Planning and Development of the Water and Related Land Resources in the Big Black River Basin." The purpose of this report is to coordinate the plan of development for the basin with existing laws and policies in the State that are pertinent to the type of improvements needed or proposed. (See State of Mississippi Report, Volume V, Annex I.)

c. Department of Agriculture. The Department of Agriculture, through the Soil Conservation Service, furnished data covering upstream watershed control and a plan of development for the watersheds. The Economic Research Service and the Forest Service furnished data on land use, production and other farm characteristics in a report entitled, "Agricultural Economic Base Study of the Big Black River Basin Study Area." (See Department of Agriculture Report, Volume II, Annex A.)

d. Department of Commerce. The Department of Commerce furnished information concerning the natural environment within the Big Black River Basin.

e. Department of Health, Education and Welfare. At the initiation of this study, the Department of Health, Education and Welfare was to conduct a water supply and water quality control study of the basin through the Federal Water Pollution Control Administration and the Public Health Service. This study was transferred with the Federal Water Pollution Control Administration to the Department of Interior. The Department of Health, Education and Welfare through the Public Health Service, reviewed the studies made by other agencies

and commented on the water quality and other health aspects of the basin.

f. Department of Interior. The Department of Interior participated as follows:

(1) The Bureau of Outdoor Recreation prepared a report on the demand, supply and needs for recreation within the Big Black River Basin Study Area. They also aided in evaluating the recreation potential of all plans considered and developed an overall recreational plan to meet the needs of the basin insofar as practicable. (See Bureau of Outdoor Recreation Report, Volume IV, Annex C.)

(2) The Bureau of Sport Fisheries and Wildlife prepared a report on the fish and wildlife demand, supply and needs for the Big Black River Basin. The Bureau also estimated the effects that the projects considered would have on conservation and development of fish and wildlife. (See Bureau of Sport Fisheries and Wildlife Report, Volume IV, Annex D.)

(3) The National Park Service furnished information on the archeological and historical value of the area. (See National Park Service Report, Volume IV, Annex G.)

(4) The U. S. Geological Survey investigated the ground water resources and general geology of the basin. This study included an inventory of water use in the basin and a survey of the existing geologic aquifer systems. (See U. S. Geological Survey Report, Volume IV, Annex F.)

(5) The Federal Water Pollution Control Administration conducted a study to determine the need for municipal and industrial water supply within the basin and the amount of surface water storage required to meet these needs; the quality of surface and ground waters; and the minimum stream flow required to maintain acceptable quality and the need for and value of storage for this purpose. (See Federal Water Pollution Control Administration Report, Volume IV, Annex E.)

g. The Federal Power Commission submitted a report on the demand, supply and needs of power within the study area. (See Federal Power Commission Report, Volume V, Annex H.)

23. DISCUSSION

a. The Big Black River Basin is located entirely in the "Hill Section" of the State of Mississippi. The basin is long and narrow, averaging 22 miles in width and 155 miles in length, with a total drainage area of approximately 3,400 square miles. There are no major tributaries of the river, but a number of small streams enter the main channel at frequent intervals throughout its length. The economy of the area is dependent primarily upon the agricultural development within the basin. Farmlands constituted almost 70 percent of the 1960 land use. Employment on these farms has decreased in recent years primarily because of the shift to mechanized farming practices. Protection of these farmlands from overflow is one of the principal needs within the basin. Damaging floods occur along the main stem of the Big Black River approximately twice each year, with the agricultural sector incurring 90 percent of the total flood damages. Recreational facilities are also needed within the basin. The recreational needs of the basin were developed for swimming, boating, camping, picnicking, hiking, nature study, and incidental fishing. This study showed an unsatisfied recreation demand for the basin throughout the study period.

b. Four types of improvements were investigated in an attempt to meet the immediate (1980) and the long-range (2015) needs for flood control and recreational development in the basin. These were: (1) reservoirs; (2) channel improvements; (3) levees; and (4) recreational facilities. The projects which were studied to satisfy these needs were designed primarily for flood control with recreation included in the reservoir projects as a purpose. A discussion of these studies is presented in the following subparagraphs.

c. Main stem reservoirs.

(1) One of the methods used for providing flood protection along the main stem of a river is to control the flows of the river by reservoirs. Three potential damsites were located along the main stem of the Big Black River. One was upstream from West, Mississippi, one near Durant, Mississippi, and another near Edwards, Mississippi. Both the West and Durant sites offer limited potential for hydro-electric power development. A reservoir at either the West or Durant site would be for flood control and recreation. Flood control benefits would be minor since both of these damsites are located in the upper end of the basin, and control only a small percentage of the basin's drainage area. Extensive relocations would be necessary for the rail-roads and highways which traverse the valley at these reservoir sites. The reservoir at Durant would require relocating the town of West, Mississippi. Valuable croplands along the main stem of the river and its tributaries would be inundated by the reservoirs.

(2) Excellent recreational areas could be developed around these reservoirs; however, these areas would be at a point removed from the basin's concentrated recreational demand which is located in the lower part of the basin. The primary benefit to be gained by the construction of a reservoir near West or Durant would be its recre-ational potential. Since both the West and Durant sites would pro-vide only limited flood control benefits to the basin and each would require extensive relocation costs, they are not desirable sites for a main stem reservoir. The reservoir site near Edwards offers the best potential for the construction of a main stem reservoir. There is an excellent damsite available which could control 80 percent of the basin's drainage area and pool water upstream for approximately 60 miles. The reservoir was investigated as a multipurpose project to include flood control, hydroelectric power and recreation as proj-ect purposes. Overall, the benefit-to-cost ratio for the project is 1.4 to 1. However, the project was economically feasible due to the large amount of recreational benefits accruing to the reservoir.

(3) The incremental benefit-to-cost ratios for flood control, hydroelectric power and recreation are 0.5, 0.6 and 1.9, respectively. A dam at this site would be located near the areas of greatest present and projected recreational demand in the basin and would satisfy all of the basin's immediate needs for recreation and a large portion of the projected needs. Even though a main stem recreational reservoir is economically justified, there is presently strong local opposition to construction of such a project. This is due primarily to the fact that the basin is agriculturally oriented and a main stem recreational reservoir would take a substantial amount of agricultural lands out of production. However, with increasing recreational demands projected for the future and an expected trend toward more urbanization and more rural nonfarm population, this local opposition is expected to decrease. Therefore, construction of recreational reservoirs should be considered in the future to meet the long-range recreational needs.

d. Tributary reservoirs. Upon finding that a main stem reservoir for flood control was not economically feasible, attention was given to controlling the flows of the tributaries as a means of providing main stem flood control. In the studies for this report, a plan involving a system of tributary reservoirs was given consideration. Seventeen possible damsites, varying in drainage area from 8 to 150 square miles, were located on various tributaries of the Big Black River. These dams were evaluated as a unit since no one of the dams by itself would control a large enough percent of the drainage area to provide a significant amount of flood protection along the main stem. The overall benefit-to-cost ratio of this project is above unity, 1.5 to 1. Incrementally, flood control has a benefit-to-cost ratio of 0.6 to 1. This can partially be accounted for because the system controls only 28 percent of the basin's drainage area and inundates a relatively large amount of valuable farmlands along the tributaries. The reservoirs would satisfy a large part of the basin's recreational demand. By constructing the tributary

reservoirs, recreational sites would be well distributed over the basin. Recreation, incrementally, has a benefit-to-cost ratio of 2.8 to 1. As is the case of the Edwards main stem reservoir, strong local opposition presently exists, but is expected to decrease in the future as the basin's economy shifts to more urban and rural nonfarm population. Therefore, construction of recreational reservoirs at selected tributary sites should be considered in the future as alternatives or supplements to a main stem recreation reservoir to meet the long-range recreation needs.

e. Main stem channel improvement. After finding that it was not economically feasible to protect the bottom lands along the river by either a main stem reservoir or tributary reservoirs, five main stem channel improvement plans were considered. Three of these plans were eliminated during preliminary investigations because they would not reduce flood stages sufficiently to realize flood control benefits. Two of the plans, one of which would control the 3-year-frequency flow and the other which would control the 1-year-frequency flow, would lower the flood stages but would incur major relocation cost. The 3- and 1-year-frequency channel improvement plans would have a benefit-to-cost ratio of 0.6 to 1 and 0.5 to 1, respectively. The benefits for these plans were also determined assuming the Soil Conservation Service's floodwater retarding structures in place. This did not materially change the benefits accruing to the channel improvements. Since the channel improvement plans were considerably lacking in economic justification, they should not be considered for construction at this time. Channel enlargement may warrant reconsideration as the basin develops.

f. Local protection projects. As investigations proceeded, it became apparent that flood protection would not be economically provided by reservoirs or channel improvements at this time. Therefore, the remaining alternative was to investigate a system of levees. The narrow valley of the Big Black River Basin and the numerous tributaries which enter the stream precluded the possibility of a

continuous levee system. Seventeen loop levee sites were investigated which would protect localized areas of 1,000 to 2,000 acres each, along the main stem. Fifteen of these sites were not feasible due to the lack of adequate sump areas for interior runoff and were eliminated. Two sites, one near Goodman, Mississippi, and another near the mouth of Apookta Creek had satisfactory sump areas, and were investigated to determine their economic feasibility. Further study revealed that neither of the two levee systems would be economically justified. The Goodman site, however, had a benefit-to-cost ratio approaching unity (0.96 to 1). Without economic development benefits this benefit-to-cost ratio would be reduced. For a project of this size, the economic development benefits would be small and would not stimulate the economy of the area. Since neither of the loop levee sites with satisfactory sump areas were economically feasible, these levee systems were rejected.

g. Navigation. Navigation studies were made primarily to determine the need for and the feasibility of providing a navigable channel within the Big Black River Basin. Preliminary studies indicated that there is no existing or prospective need for a navigable waterway. During the course of that study, the Mississippi State Legislature created a commission for the purpose of developing a multiple-purpose waterway connecting the Jackson, Mississippi, area with the Mississippi River. Three possible routes traversing the Big Black River Basin were identified. None of these routes are economically feasible at this time. Further consideration of such a waterway might be warranted in the future as the need for navigation becomes more pressing.

h. Additional information on the plans considered called for by Senate Resolution 148, 85th Congress, adopted 28 January 1968, is contained in Attachment No. 1 to this report.

24. CONCLUSIONS

a. There is at present and will be in the future a need for flood control on the main stem of the Big Black River. Providing flood control on the main stem by the construction of main stem reservoirs, tributary reservoirs, main stem channel improvements, levees, or various combinations of these plans is not economically feasible at this time.

b. Flood damage reduction in the Big Black River Basin can be achieved through nonstructural measures by better management and proper development and use of the flood plains. Guidance to this end is available through Corps of Engineers flood plain information reports and technical services. The U. S. Weather Bureau flood forecasting and flood warning services also offers an opportunity for reducing flood damages without structural measures.

c. The existing supply of outdoor recreation resources and facilities in the Big Black River Basin falls short when compared with the present recreation demand of the basin. This need will increase rapidly with the expected economic development and population increases in the basin. Recreational development provided by construction of single-purpose recreation reservoirs or the inclusion of recreation as a project purpose in a multipurpose reservoir is economically feasible at this time. Development at the reservoirs would satisfy the present unsatisfied recreation demand and a large portion of the anticipated future demand. These reservoirs would inundate productive farmland in the basin. There is presently strong local opposition to the construction of recreation reservoirs in the basin. As the recreation demand increases in the future and the economy becomes more urbanized, opposition may decrease and local support develop for recreation reservoirs. Therefore, construction of recreation reservoirs in the future to meet the long-range recreation needs should be considered.

d. There is a need for hydroelectric power in the market area which includes the Big Black River Basin. At this time it is not economically feasible to develop hydroelectric power in the basin.

e. There is no immediate need for additional surface water storage for municipal and industrial uses in the basin because abundant supplies of good quality ground water are available. Future water requirements are also expected to be met from ground water sources. No storage for water quality control purposes is presently required since the Big Black River is a stream of good quality and only a few isolated problems exist on the tributary streams. The water quality control standards being developed in connection with the Federal Water Pollution Control Act should help the quality of the streams remain good and should also help correct conditions on the tributary streams.

f. There is no existing or prospective need for waterborne transportation in the Big Black River Basin proper. A navigable channel connecting the Mississippi River at Vicksburg with the Pearl River at Jackson, Mississippi, is not economically feasible at this time.

25. RECOMMENDATIONS

a. No modification of the existing projects on the Big Black River with respect to flood control and allied purposes be undertaken at this time.

b. Each county within the basin be encouraged to request that flood plain information reports be prepared; appropriate use of available technical services be encouraged; and improvement of flood forecasting and flood warning services be continued by the U. S. Weather Bureau.

c. Further consideration be given to main stem channel improvement as a means of providing flood protection at such time as the economic development of the basin warrants.

d. Further consideration be given to multiple-purpose reservoirs on the main stem and on selected tributaries for the basin's long-range plan of development.


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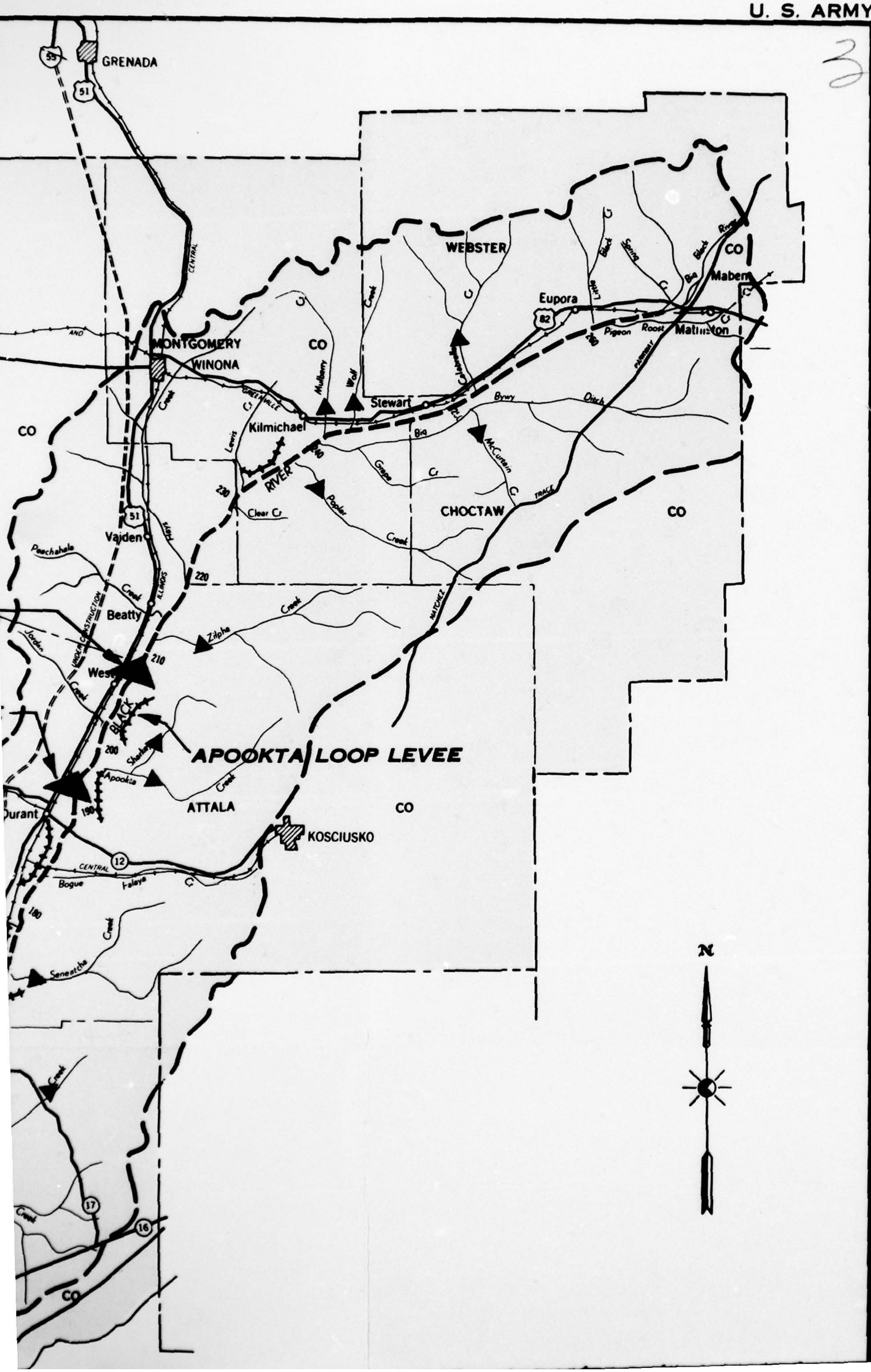
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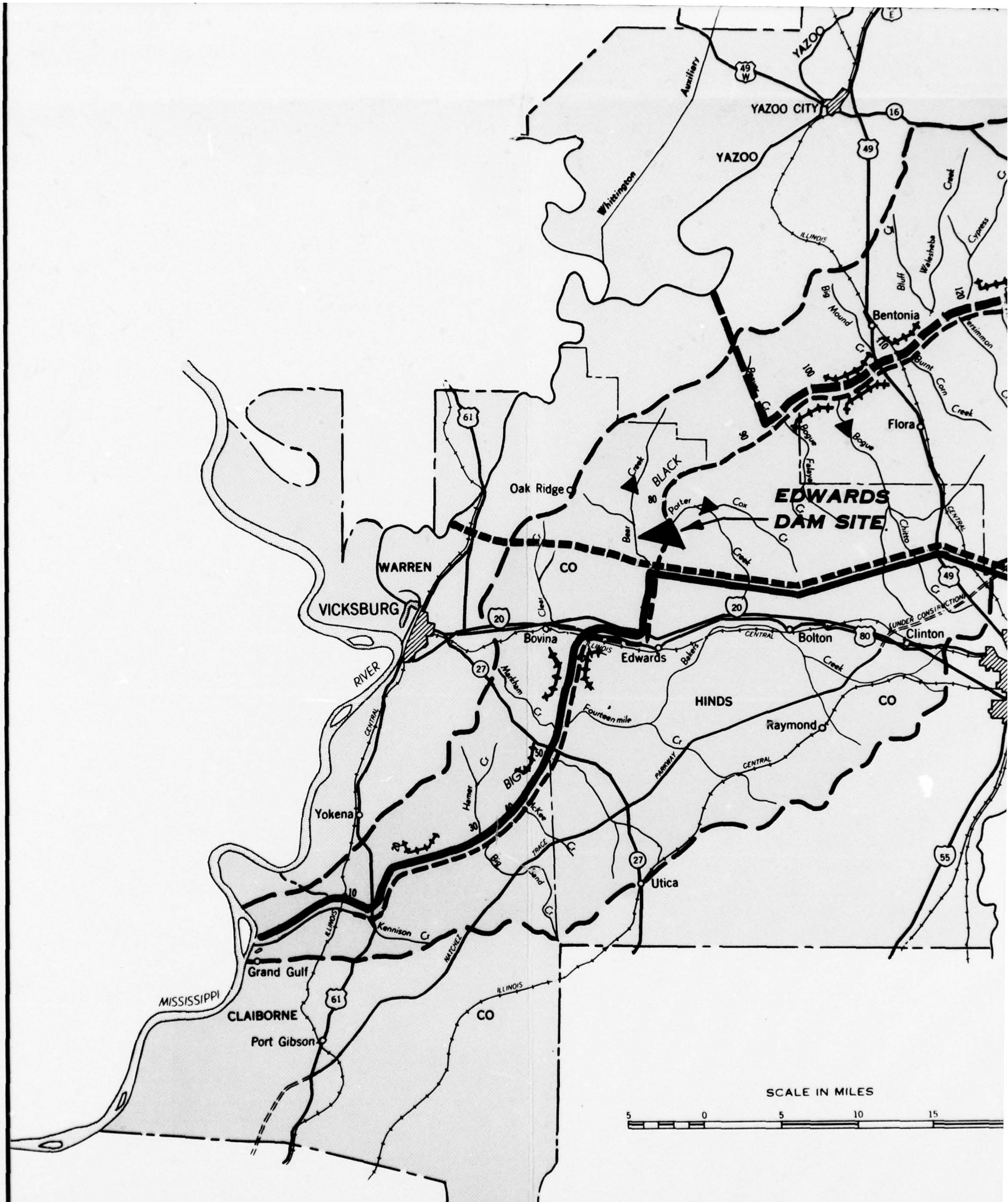

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WARREN
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Bovina
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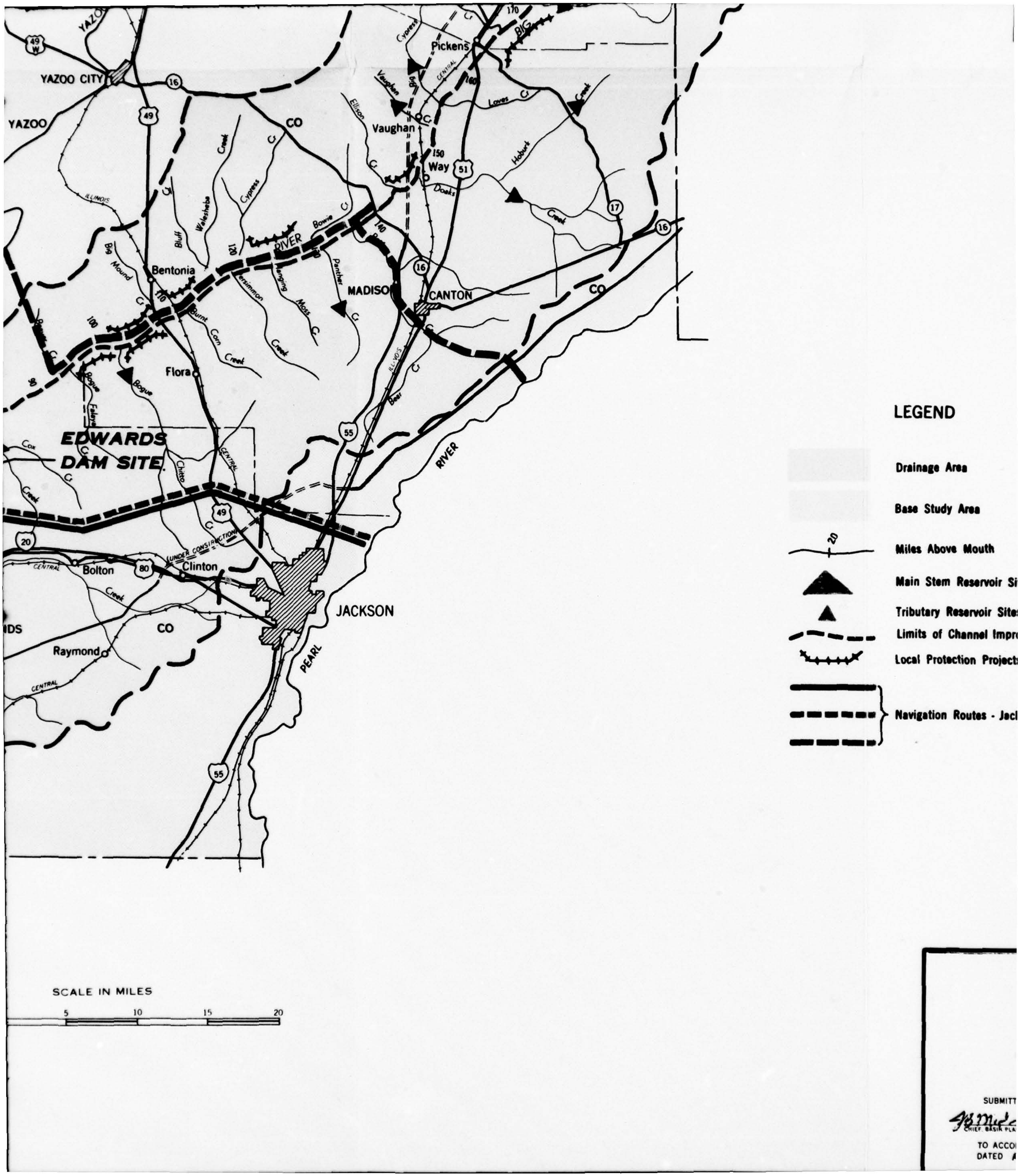

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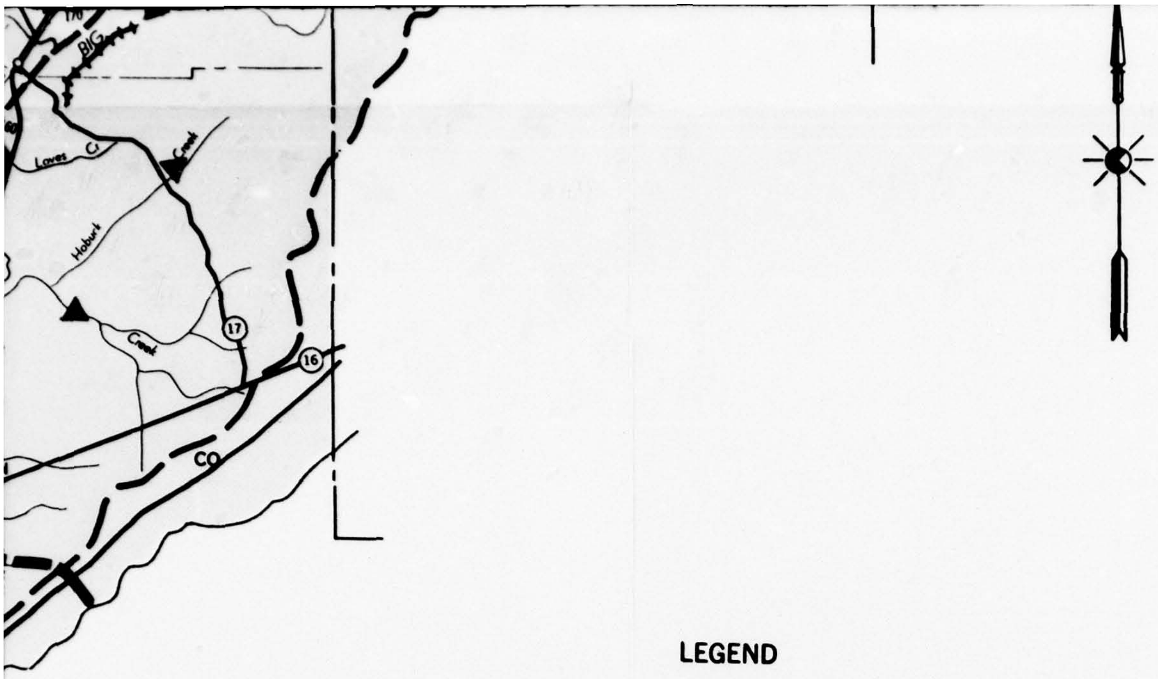


LEGEND

Drainage Area

Base Study Area

20

Miles Above Mouth

Main Stem Reservoir Sites

Tributary Reservoir Sites

Limits of Channel Improvement Plans

Local Protection Projects (Loop Levees)

Navigation Routes - Jackson Miss. to Miss. River

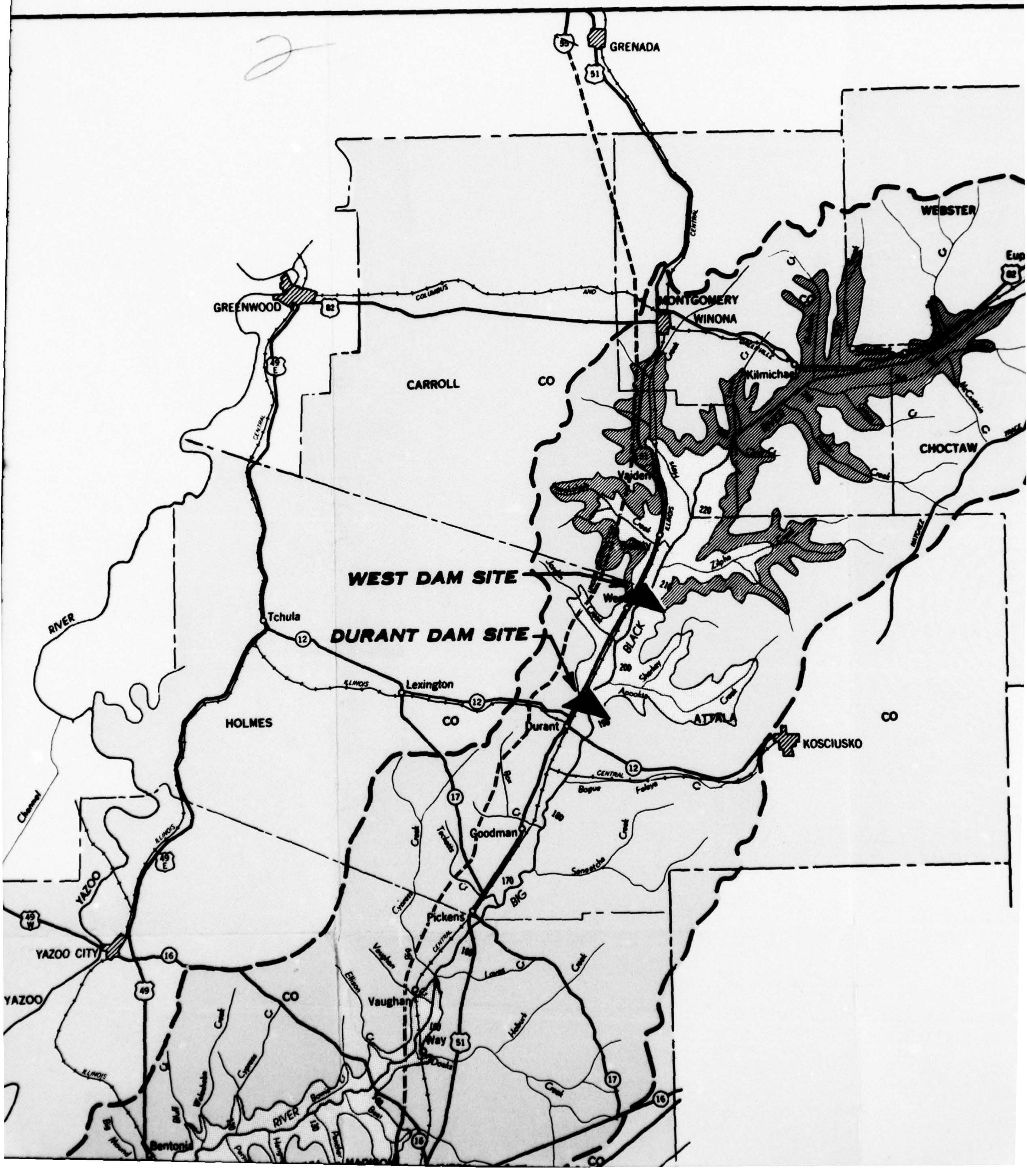
LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY
INDEX MAP
SCALE AS SHOWN
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SUBMITTED BY	APPROVAL RECCOMENDED	APPROVED
CHIEF, BASIN PLANNING BRANCH	CHIEF, ENGINEER DIVISION	COL. CORPS OF ENGINEERS DISTRICT ENGINEER

TO ACCOMPANY CORPS OF ENGINEERS REPORT
DATED APRIL 1968

FILE NO. BB-14-9

CORPS OF ENGINEERS



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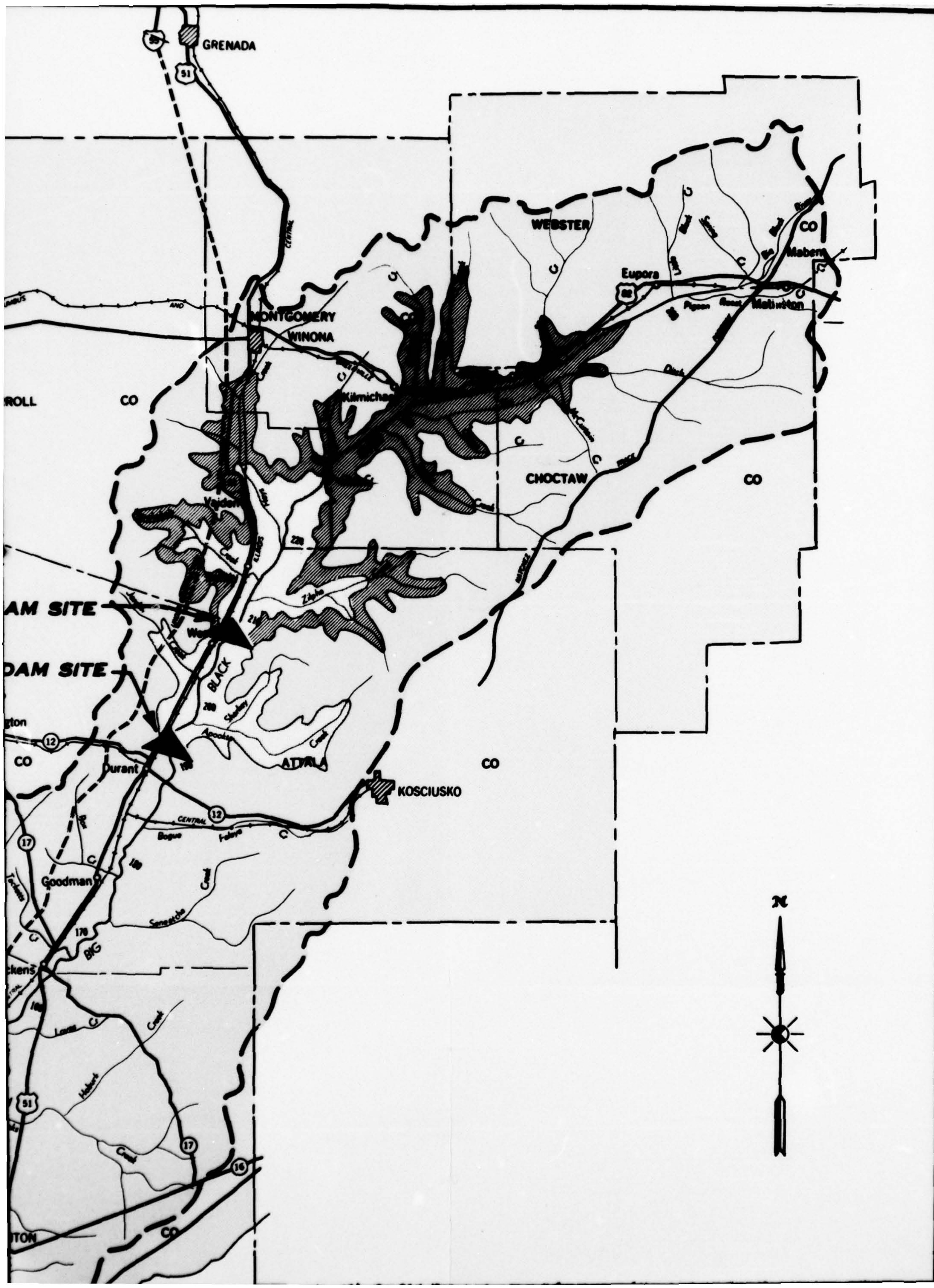

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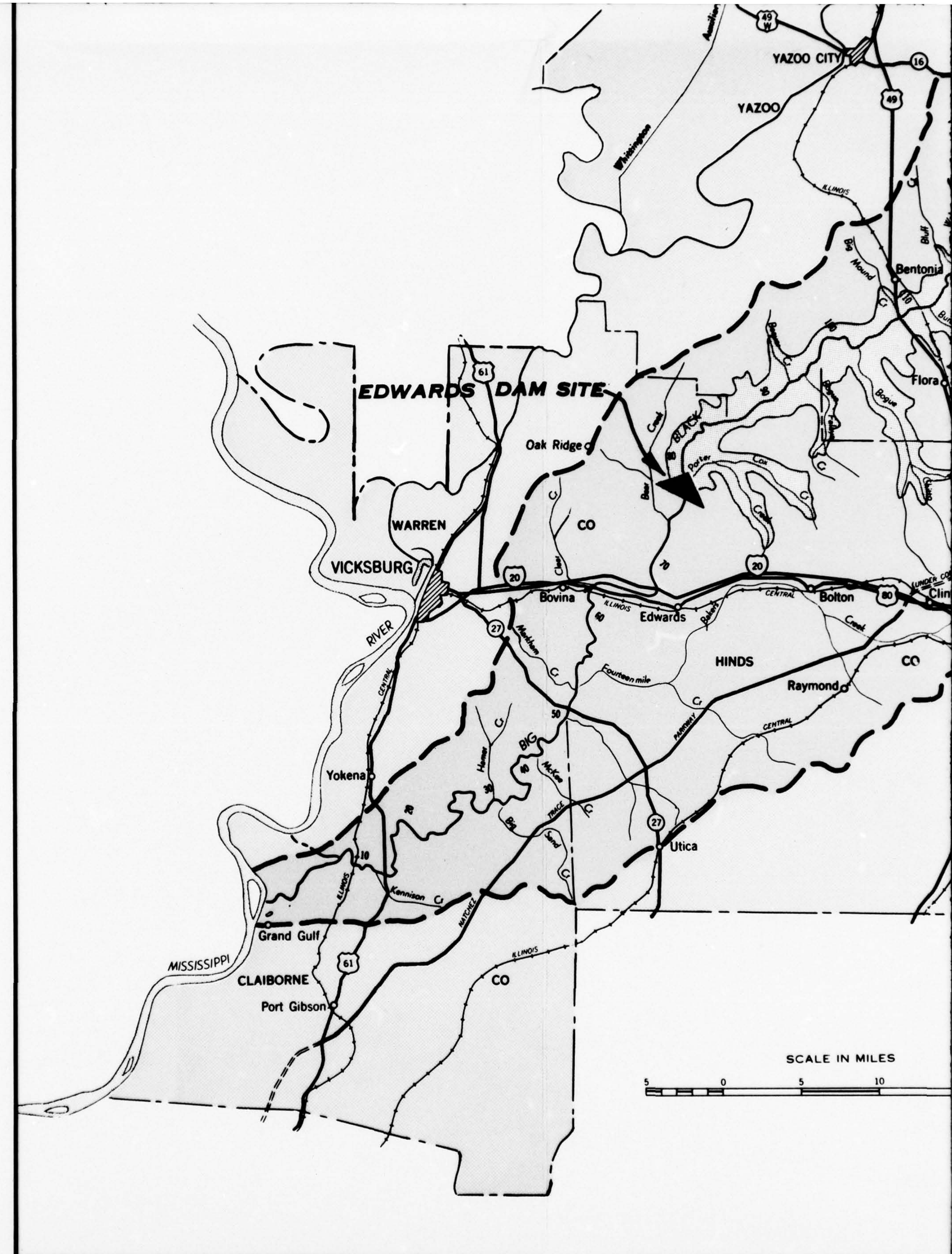

EDWARDS DAM SITE
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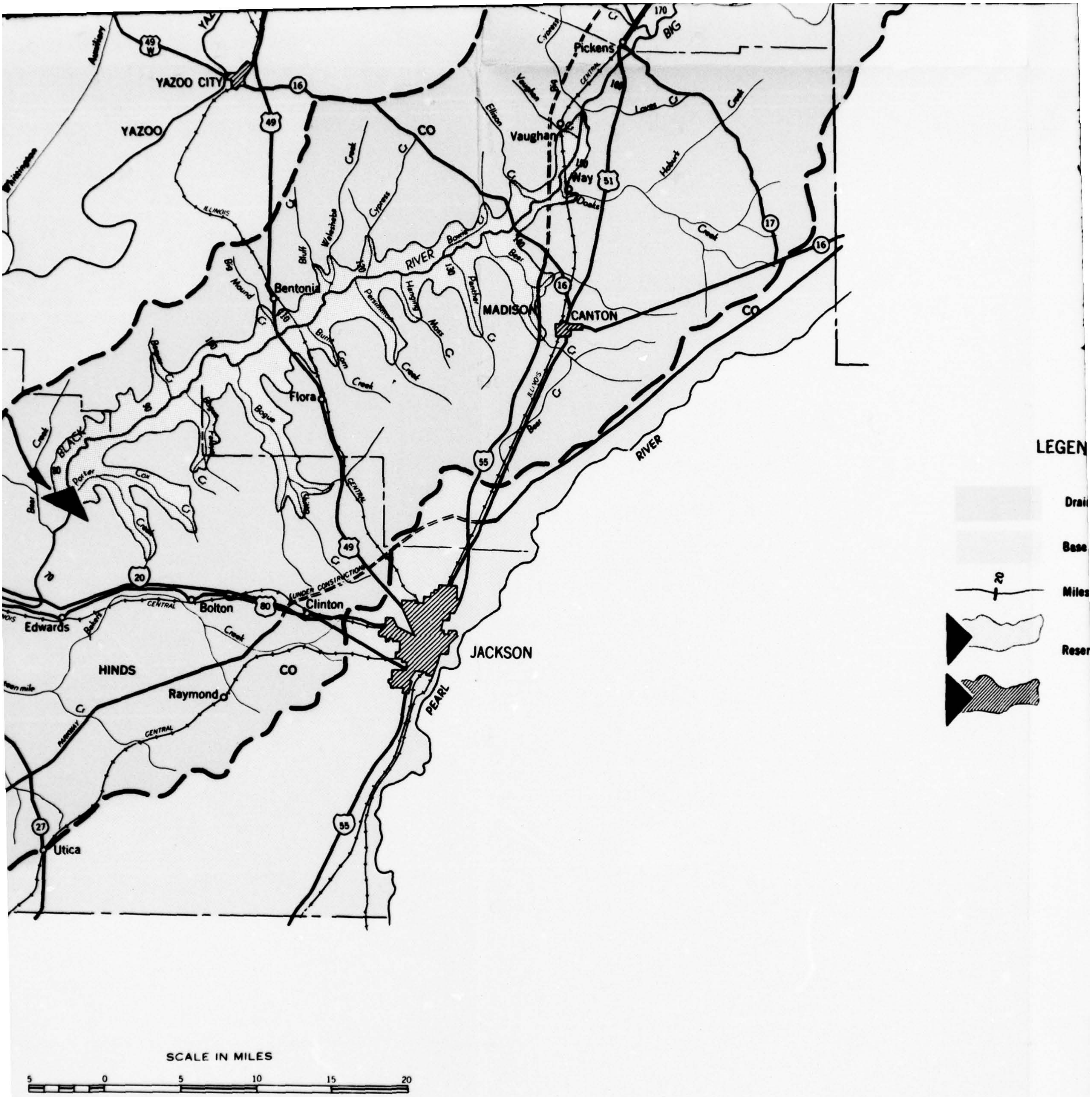

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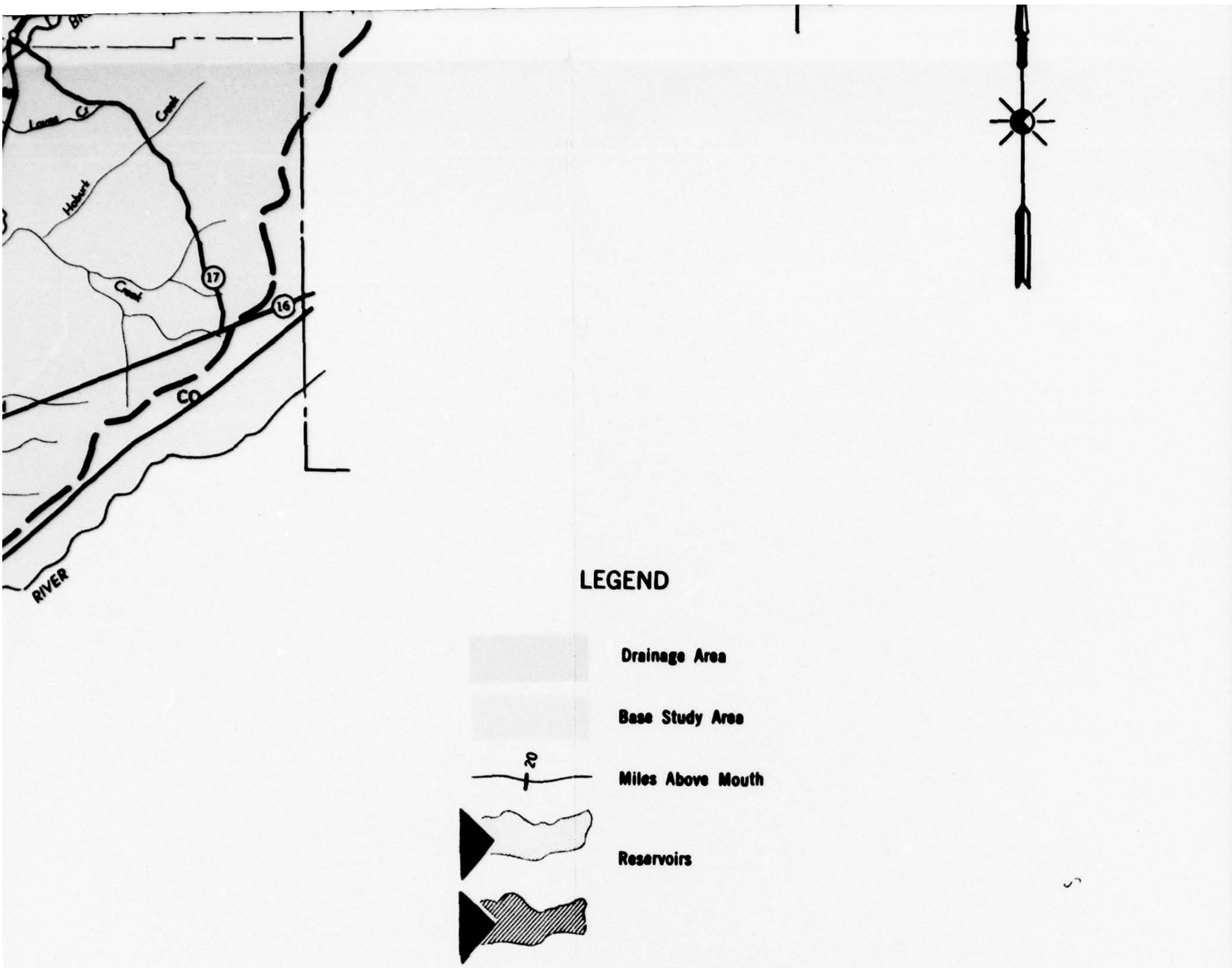


LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

PLANS CONSIDERED
MAIN STEM RESERVOIRS

SCALE AS SHOWN

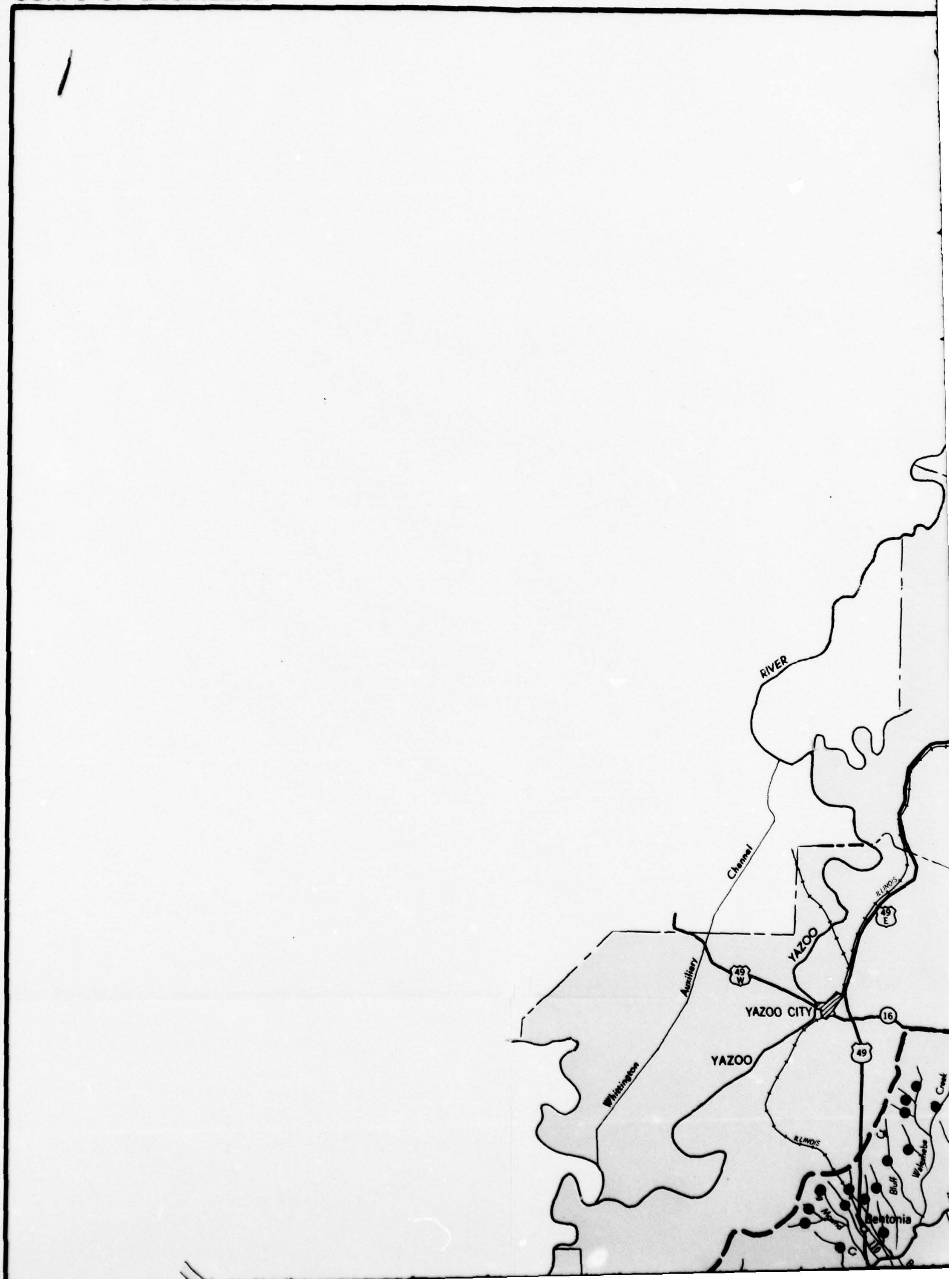
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

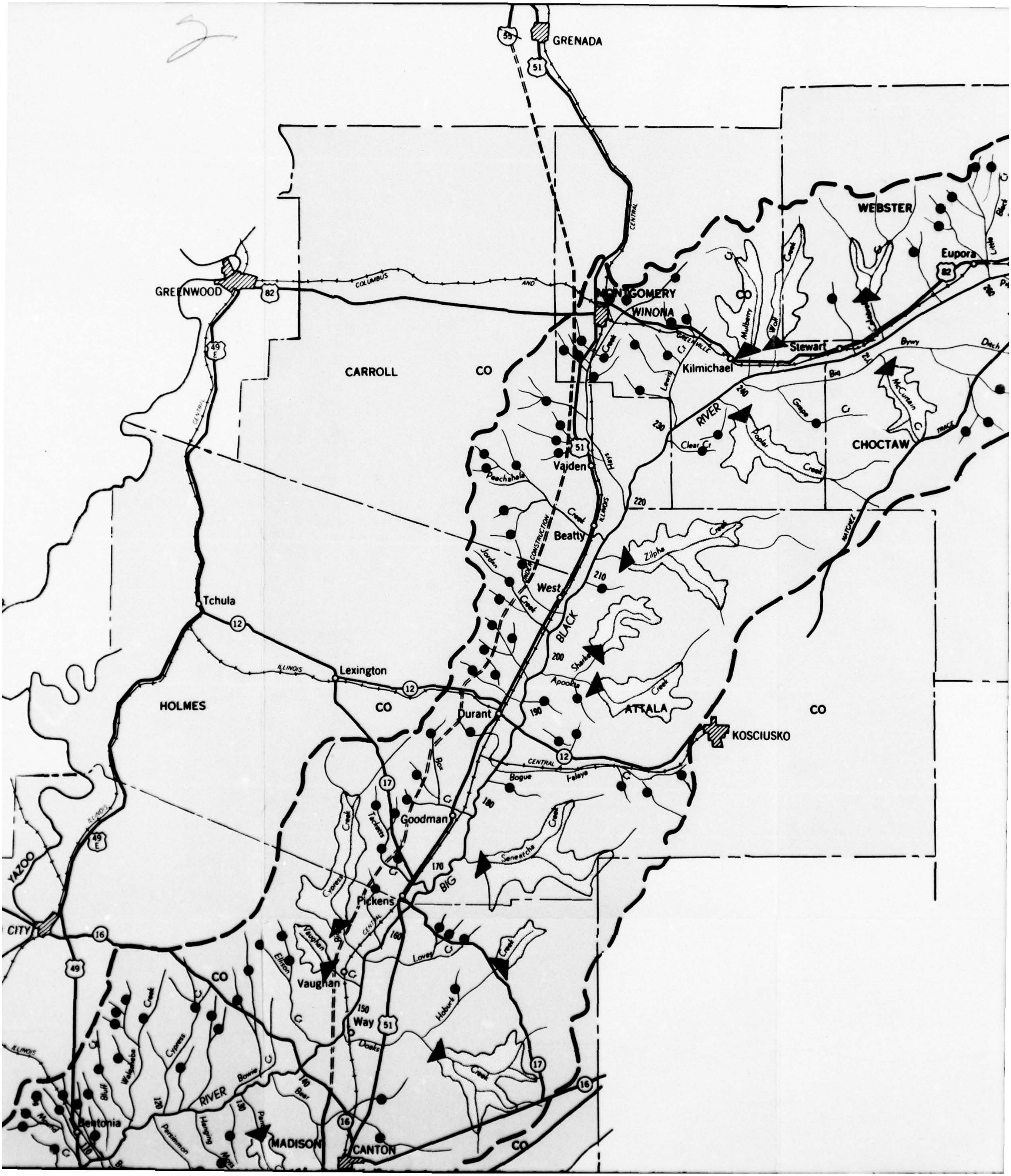
FILE NO. BB-14-9

PLATE 2

6

CORPS OF ENGINEERS





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Jordan
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West
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Tchula
12
BLACK
Lexington
ILLINOIS
12
200
Shankin
Apookta
Creek
HOLMES
CO
Durant
ATTALA
CO
190
KOSCIUSKO
12
CENTRAL
Bogue
Falaya
Box
17
Goodman
Tacketts
Creek
180
Cypress
Creek
Seneatcha
170
BIG
YAZOO
49 E
Pickens
ILLINOIS
CITY
16
49
Vaughan
Vaughan
CENTRAL
160
Loves Cr
Creek
Ellison
CO
Way
150
51
Hoburk
Creek
Cypress
Bluff
Wolfs
17
Docks
Bowie
RIVER
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Bear
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Hanging
Persimmon
Bentonia
Mound
16
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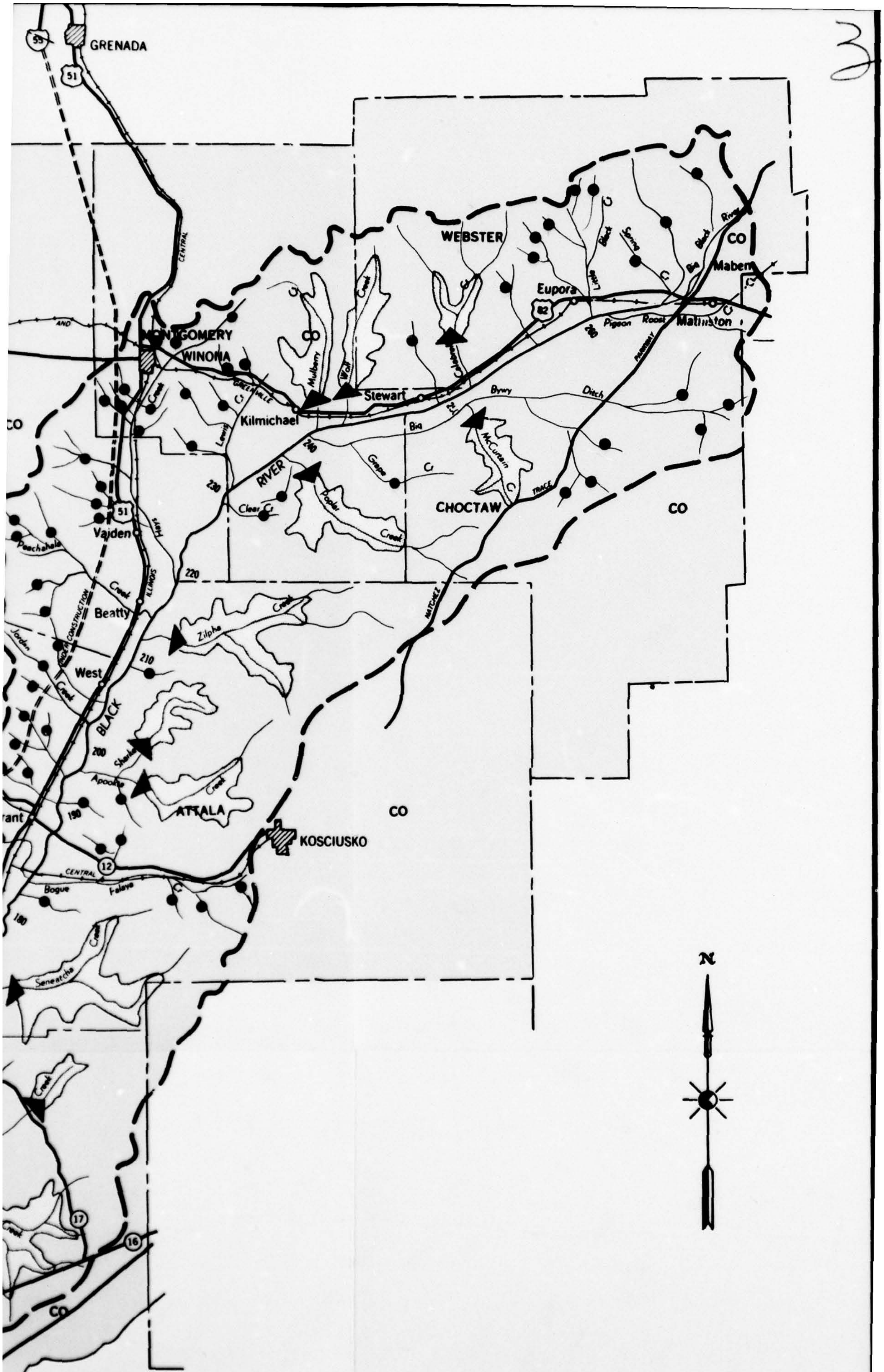
MADISON
CANTON
CO

3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CENTRAL
WEBSTER
CO
Maben
Eupora
82
Mathiston
Pigeon Roost
MONTGOMERY
WINONA
CO
Stewart
Kilmichael
Mulberry
Wolf
Big Black River
RIVER
Big
Ditch
Grape
Poplar
Clear Cr
McCurtain
TRACE
NATCHEZ
CHOCTAW
CO
Vajden
Peachahala
Creek
Beatty
West
Jordan
Zilpha
BLACK
Apookta
Creek
ATTALA
CO
KOSCIUSKO
Canton
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CENTRAL
Bogue
Falaya
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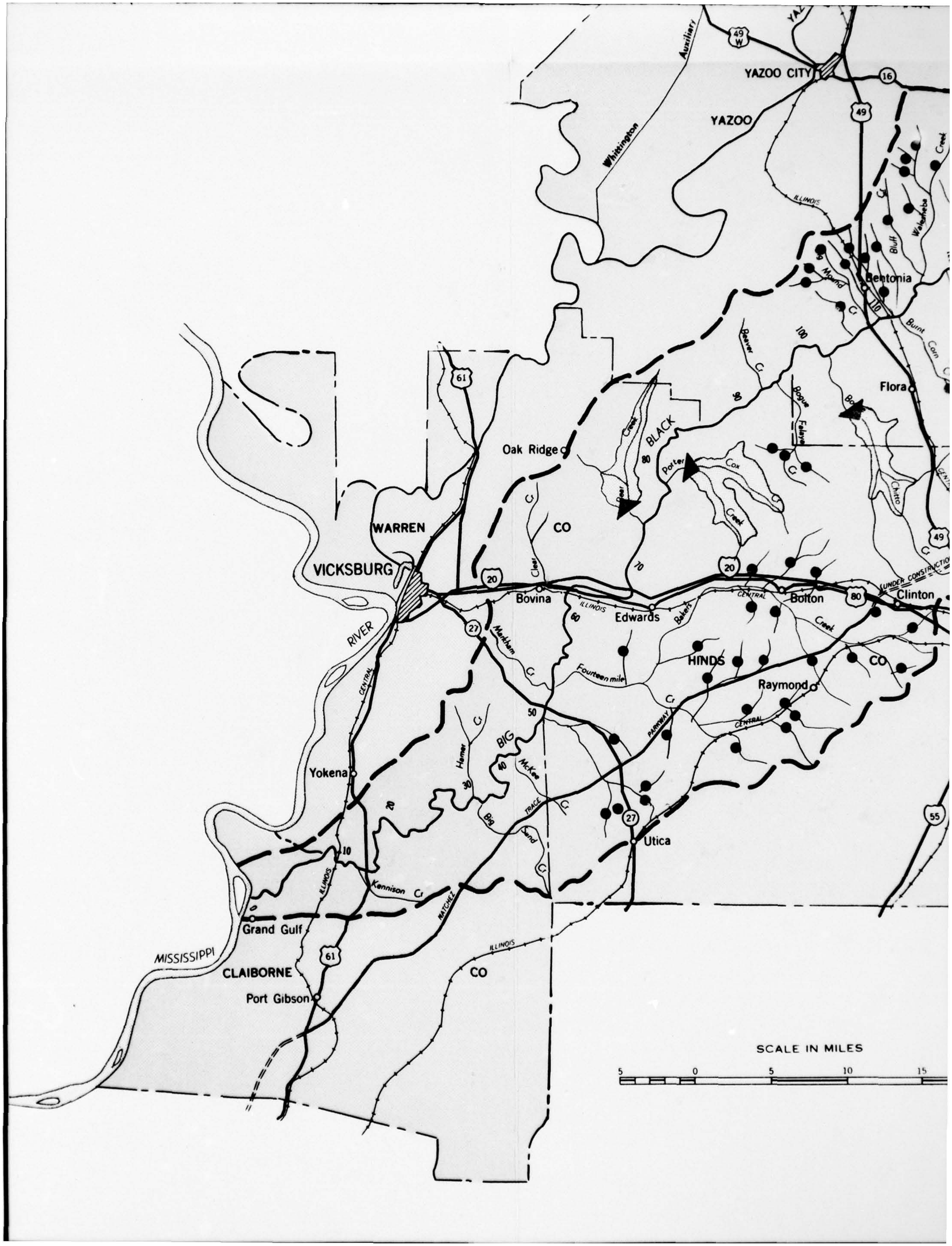
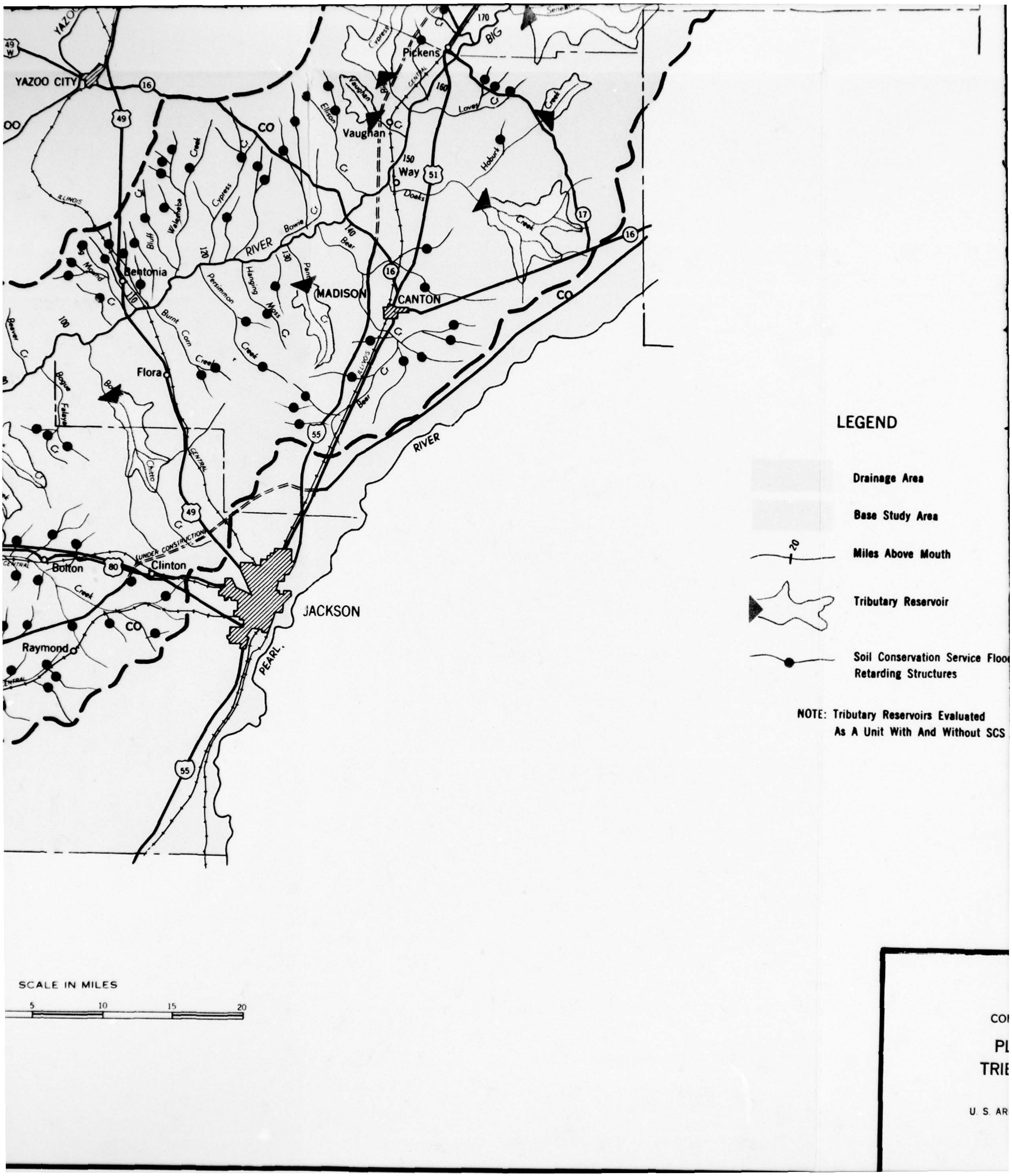
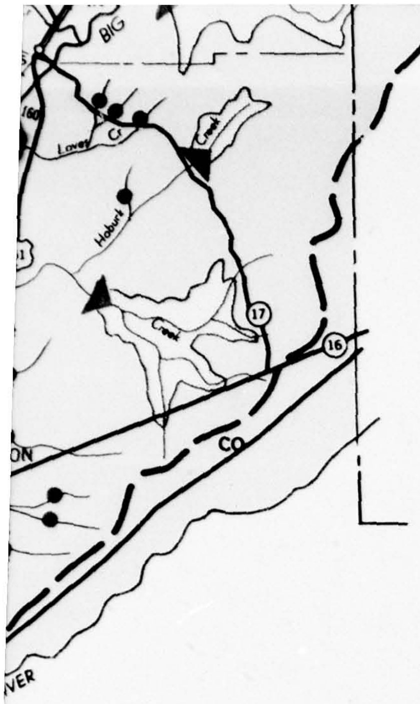


YAZOO CITY
YAZOO
Whittington
Auxiliary
ILLINOIS
Bentonia
Bluff
Wolf Creek
Burnt Corn
Flora
Beaver Cr
Bogue Falaya
BLACK
Porter
Cox
Creek
Oak Ridge
WARREN
CO
VICKSBURG
RIVER
Bovina
Edwards
Bolton
Clinton
UNDER CONSTRUCTION
CENTRAL
Bakers
Creek
Clear
Cr
Markham
Fourteen mile
HINDS
CO
Raymond
PARKWAY
CENTRAL
BIG
Hamer
McKee
Big
TRACE
Sand
Yokena
Utica
Kennison Cr
NATCHEZ
ILLINOIS
Grand Gulf
MISSISSIPPI
CLAIBORNE
Port Gibson
CO
SCALE IN MILES
5
0
5
10
15


YAZOO CITY
Pickens
Vaughan
Way
Bentonia
MADISON
CANTON
Flora
Bolton
Clinton
JACKSON
Raymond
BIG
RIVER
PEARL
CO
UNDER CONSTRUCTION
LEGEND
Drainage Area
Base Study Area
Miles Above Mouth
Tributary Reservoir
Soil Conservation Service Flood Retarding Structures
NOTE: Tributary Reservoirs Evaluated As A Unit With And Without SCS
SCALE IN MILES
5
10
15
20
CO
PL
TRIB
U. S. AR



LEGEND

Drainage Area

Base Study Area

20

Miles Above Mouth

Tributary Reservoir

Soil Conservation Service Floodwater Retarding Structures

NOTE: Tributary Reservoirs Evaluated As A Unit With And Without SCS Structures

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

PLANS CONSIDERED
TRIBUTARY RESERVOIRS

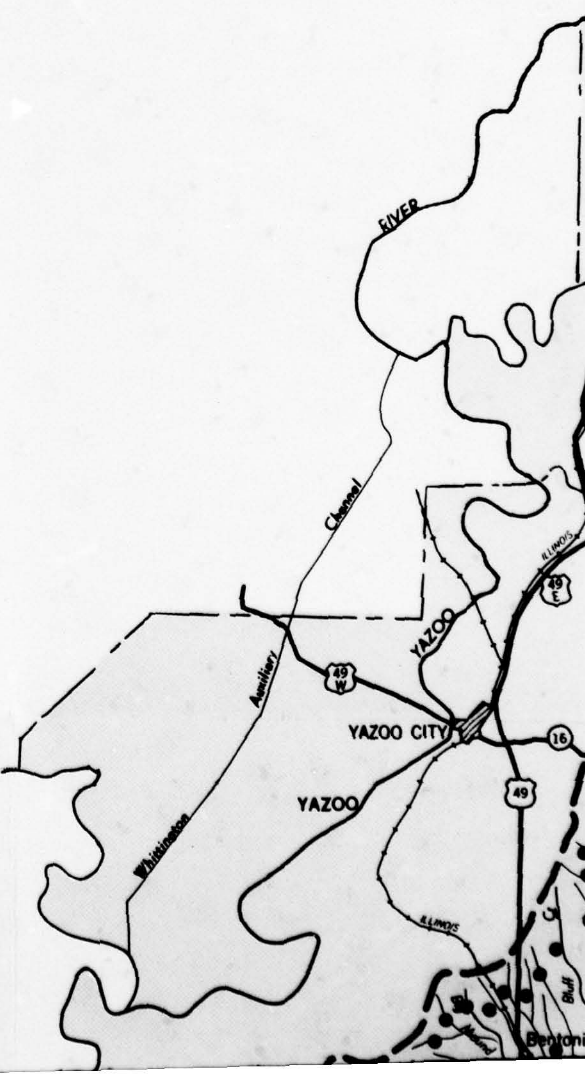
SCALE AS SHOWN

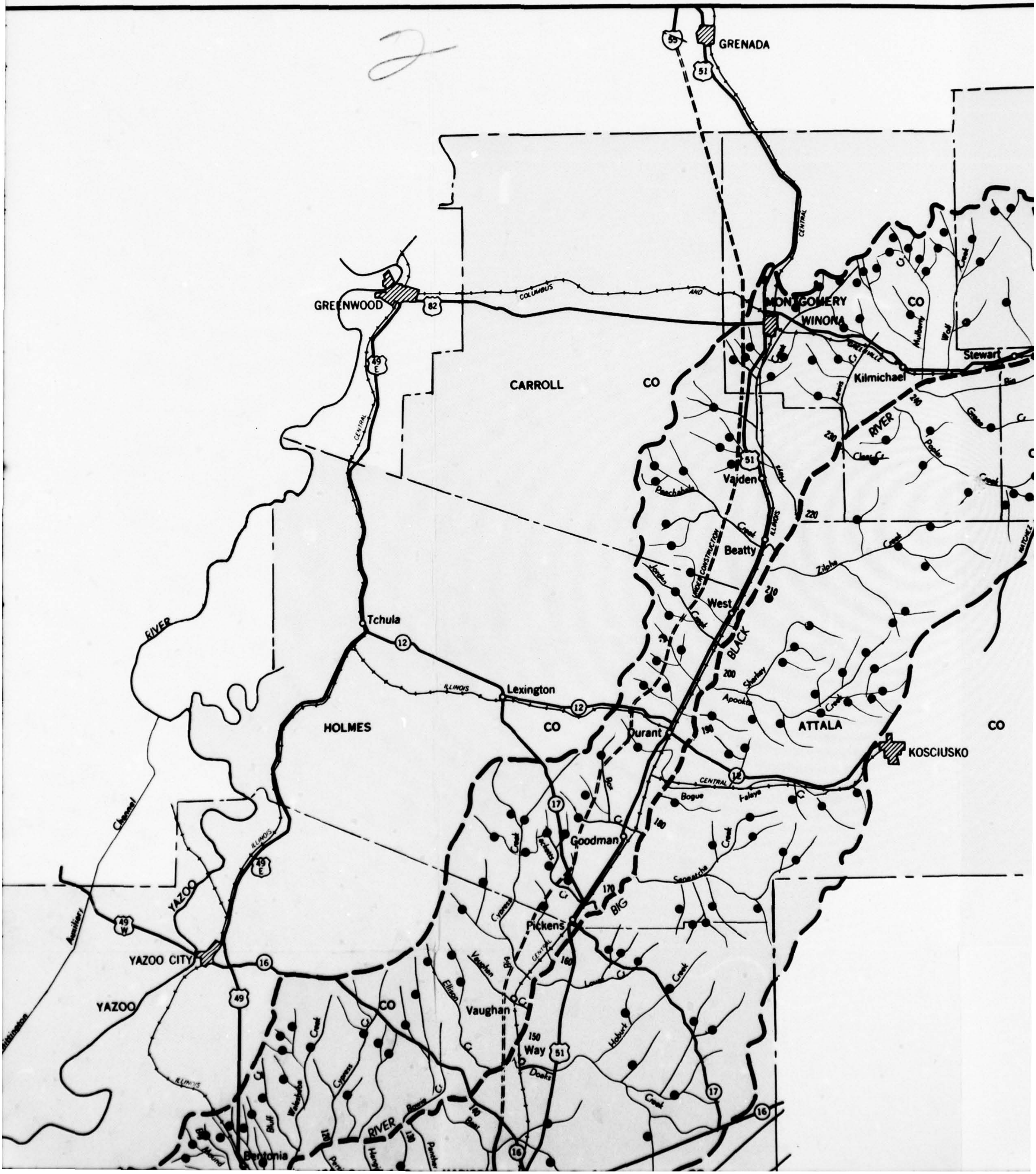
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

PLATE

CORPS OF ENGINEERS




GRENADA
MONTGOMERY
WINONA
CO
Stewart
Kilmichael
GREENWOOD
CARROLL
CO
Vaiden
Beatty
West
Tchula
Lexington
HOLMES
CO
Durant
ATTALA
CO
KOSCIUSKO
Goodman
Pickens
BIG
BLACK
RIVER
YAZOO
RIVER
YAZOO CITY
YAZOO
CO
Vaughan
Way
Bentonia
COLUMBUS
AND
GREENVILLE
CENTRAL
ILLINOIS
UNDER CONSTRUCTION
Peachahala
Jordan
Creek
Zilpha
Apookta
Bogue
Senasha
Cypress
Ellison
Hoburk
Bear
Perry
Vaughan
Doaks
Channel
Auxiliary
Mulberry
Poplar
Clear Cr.
240
230
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190
180
170
160
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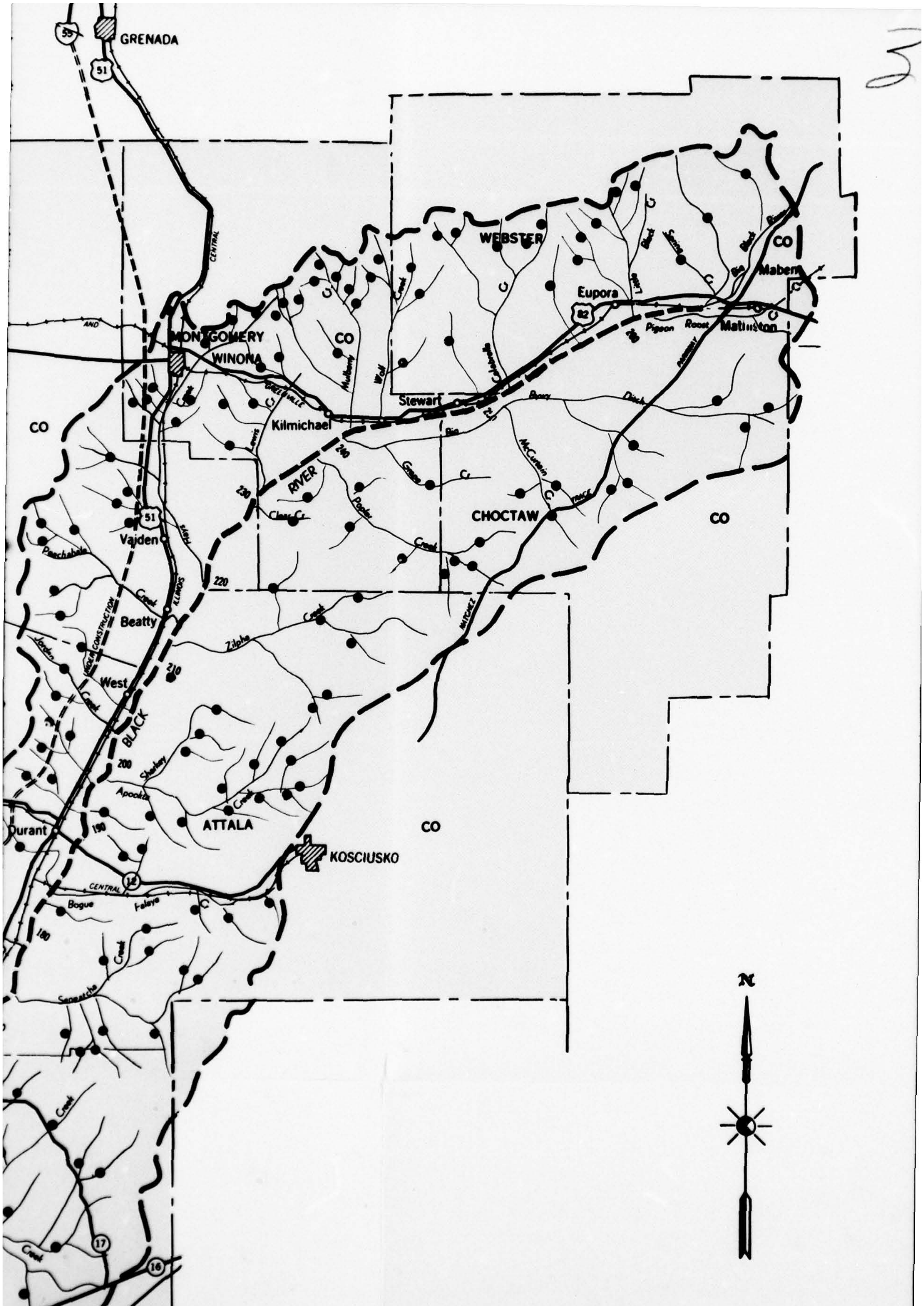
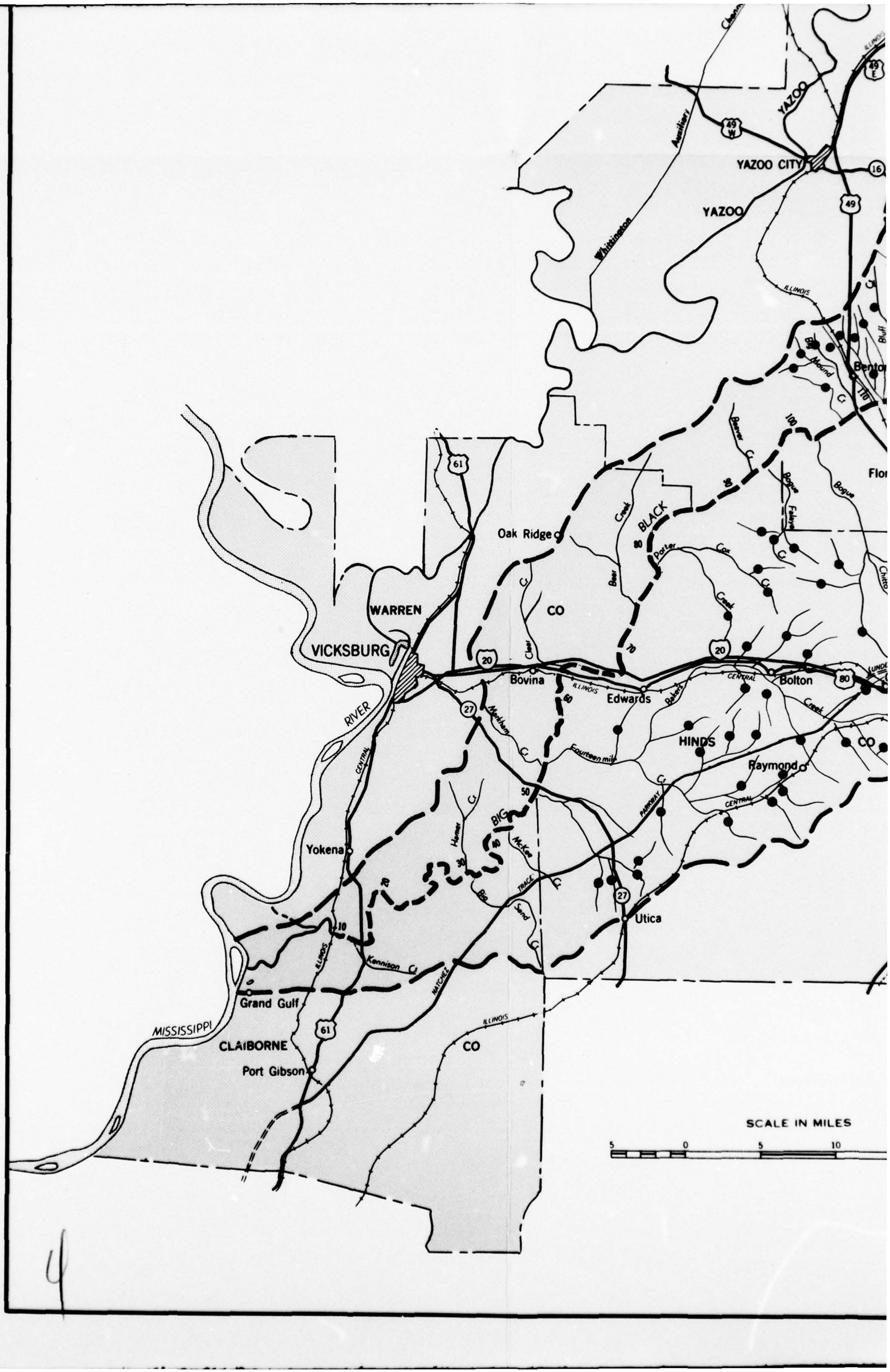
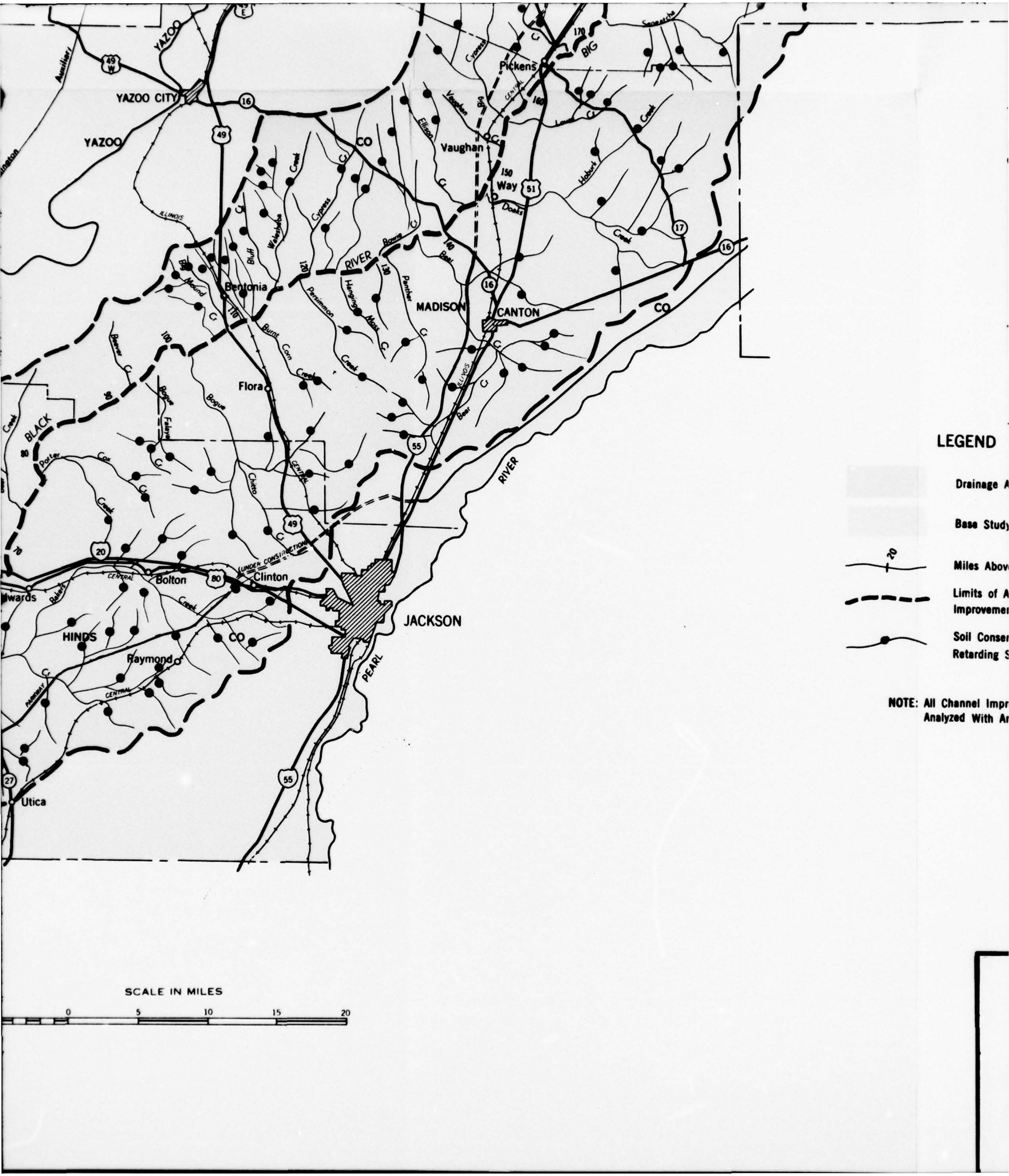
55
51
82
49 E
49 W
49
12
16
17

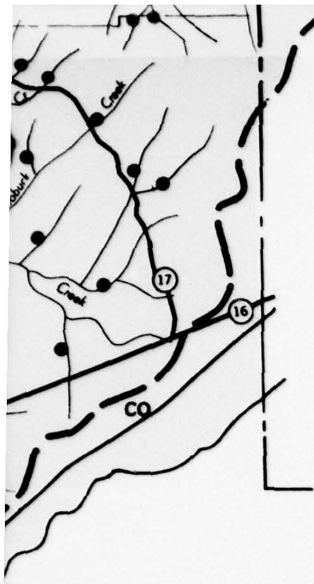


GRENADA
MONTGOMERY
WINONA
CO
WEBSTER
Eupora
Mabens
Mathiston
Stewart
Kilmichael
CHOCTAW
Vaiden
Beatty
West
BLACK
RIVER
ATTALA
Durant
KOSCIUSKO
CENTRAL
ILLINOIS
Pigeon Roost
Zilpha Creek
Apookta
Bogue Faleya
Seneatcha
NATCHEZ TRACE
240
230
220
210
200
190
180


YAZOO CITY
YAZOO
YAZOO
Whittington
Auxiliary
ILLINOIS
Big
Mound
Bluff
Benton
Beaver
Bogue
Falaya
Flor
BLACK
Creek
Bear
Porter
Cox
Creek
Oak Ridge
WARREN
VICKSBURG
CO
Clear
Bovina
ILLINOIS
Edwards
Bakers
CENTRAL
Bolton
Creek
HINDS
CO
Fourteen mile
Raymond
Montham
RIVER
CENTRAL
PARKWAY
CENTRAL
BIG
Yokena
Hamer
McKee
TRACE
Big
Sand
Utica
ILLINOIS
Kennison
NATCHEZ
Grand Gulf
MISSISSIPPI
CLAIBORNE
Port Gibson
ILLINOIS
CO
SCALE IN MILES
5
0
5
10
4



YAZOO CITY
YAZOO
YAZOO
Pickens
Vaughan
Way
BIG
Bentonia
MADISON
CANTON
CO
CO
Flora
Bolton
Clinton
Edwards
JACKSON
HINDS
CO
Raymond
Utica
PEARL
RIVER
RIVER
BLACK
Cypress
Vaughan
Big
Ellison
Hobart
Doaks
Bear
Bluff
Wolfe Creek
Persimmon
Hanging Moss
Panther
Burnt Corn Creek
Bogue
Beaver Cr
Porter
Cox
Chitto
Bakers Creek
Creek
ILLINOIS
CENTRAL
UNDER CONSTRUCTION
170
160
150
140
130
120
110
100
90
80
70
49
16
51
17
55
20
80
27
SCALE IN MILES
0
5
10
15
20
LEGEND
Drainage A
Base Study
20
Miles Above
Limits of A
Improvemen
Soil Conser
Retarding S
NOTE: All Channel Impr
Analyzed With Ar



LEGEND

Drainage Area

Base Study Area

20 — Miles Above Mouth

Limits of All Channel Improvement Plans

Soil Conservation Service Floodwater Retarding Structures

NOTE: All Channel Improvement Plans Analyzed With And Without SCS Structures

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI

COMPREHENSIVE BASIN STUDY

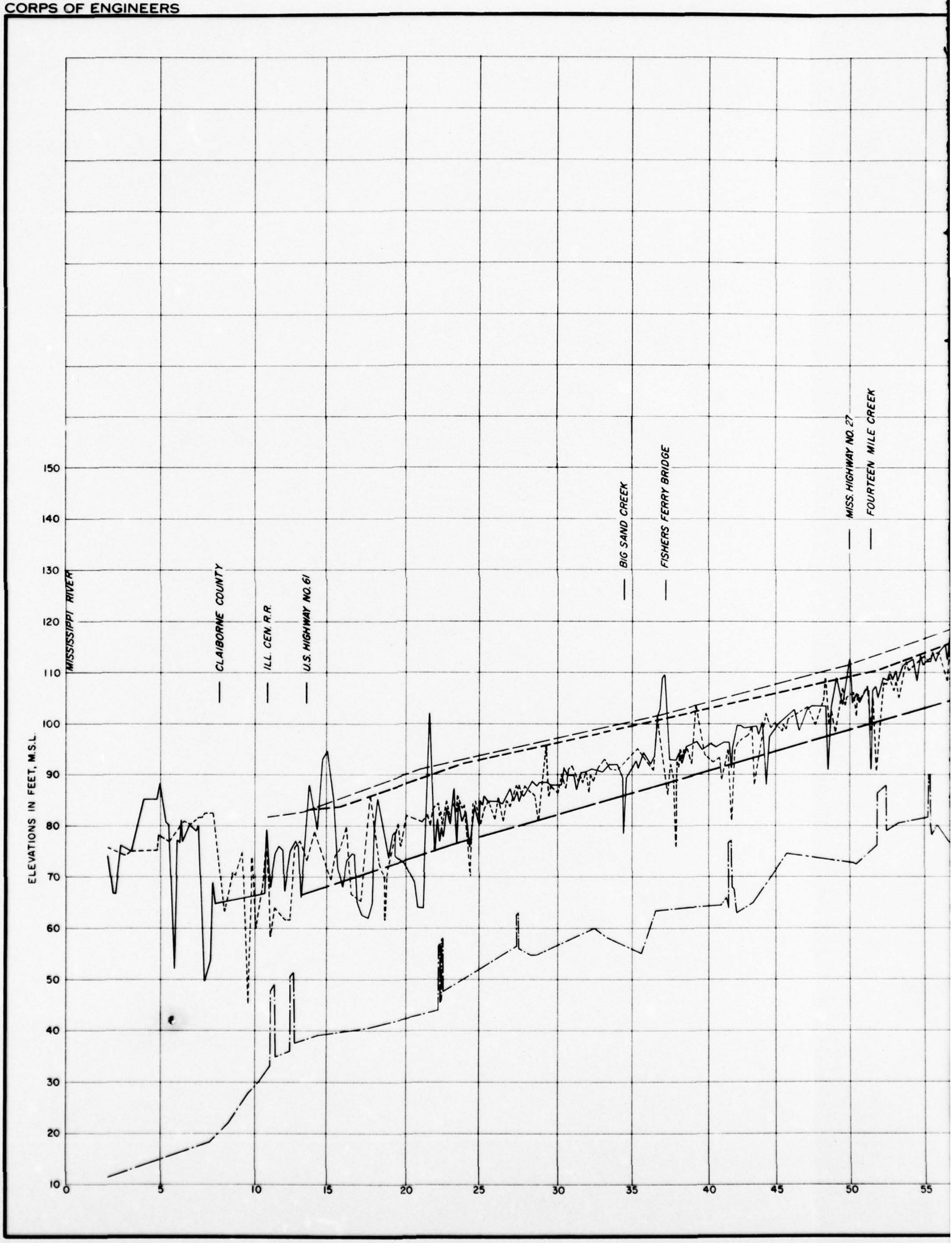
PLANS CONSIDERED
MAIN STEM CHANNEL IMPROVEMENT

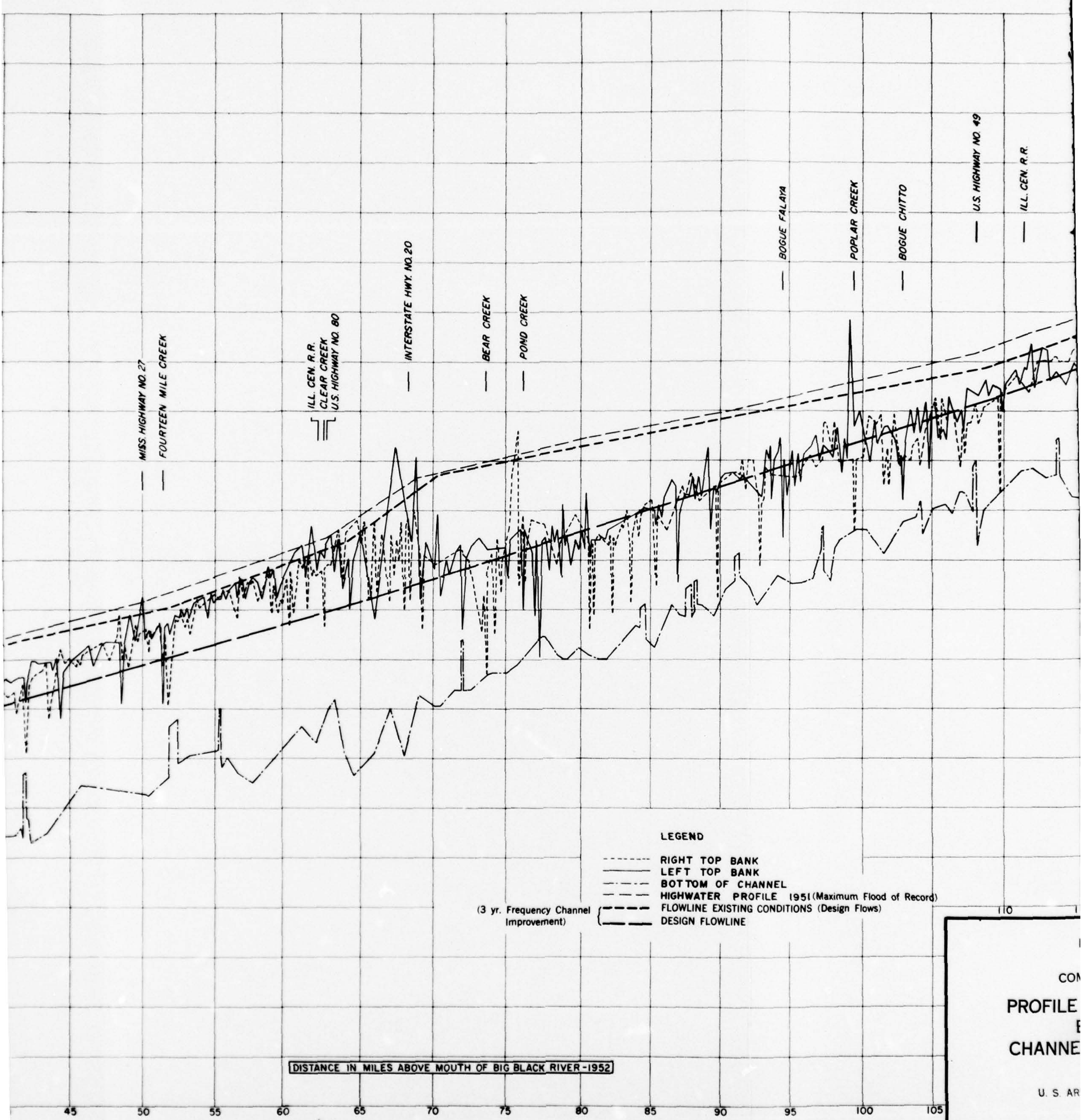
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

CORPS OF ENGINEERS





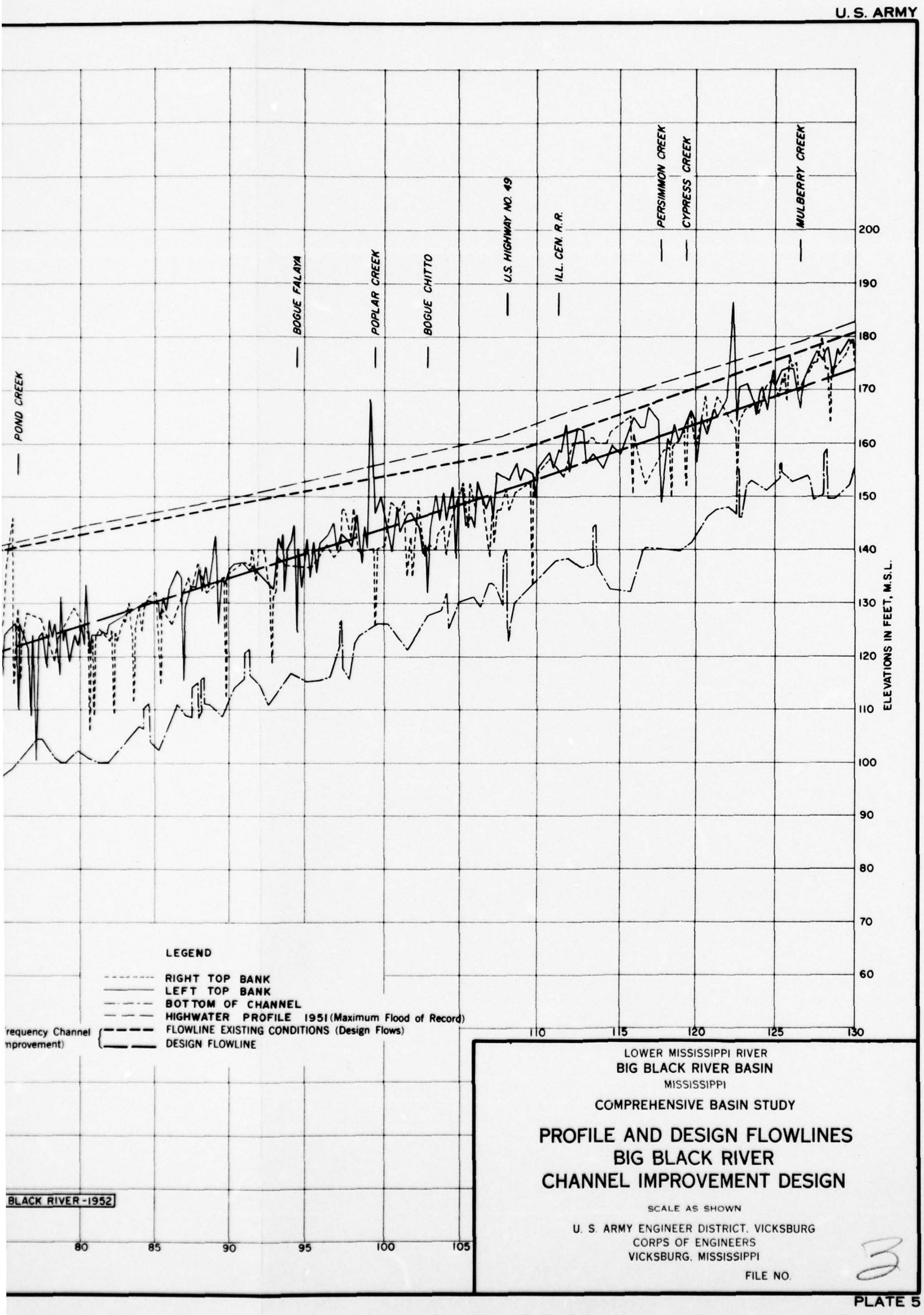
COM

PROFILE

CHANNE

U. S. AR

2



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

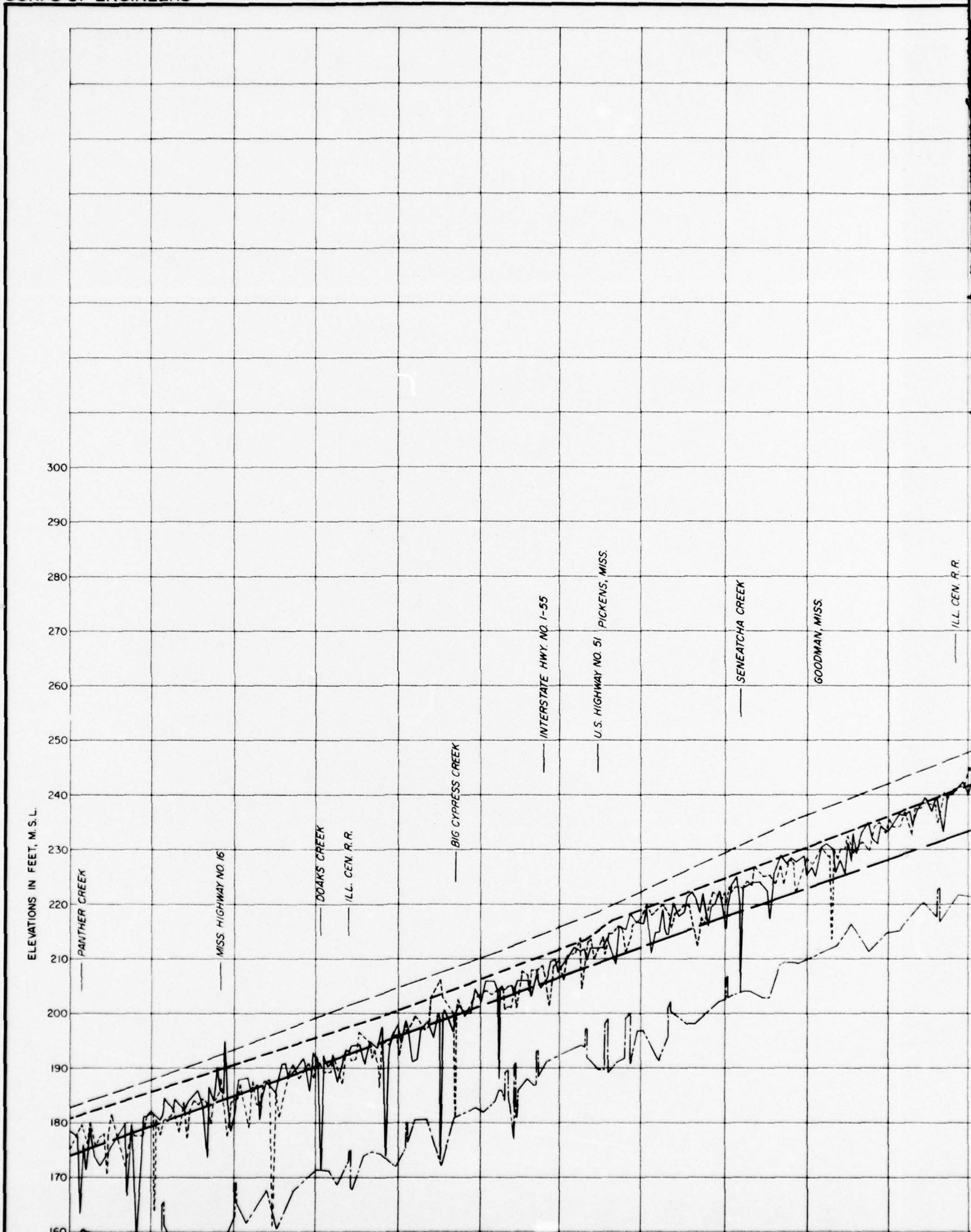
PROFILE AND DESIGN FLOWLINES
BIG BLACK RIVER
CHANNEL IMPROVEMENT DESIGN

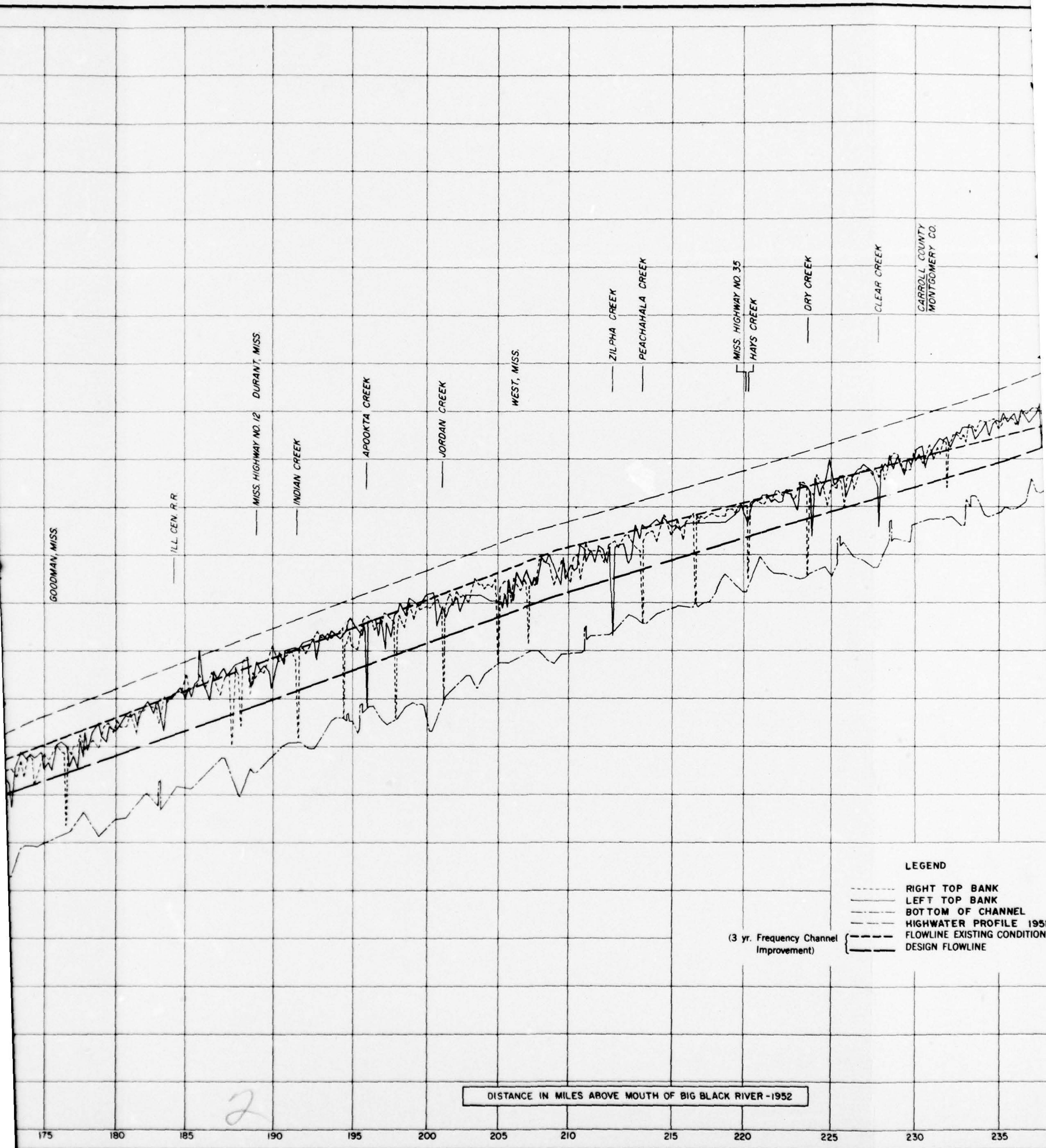
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. 3

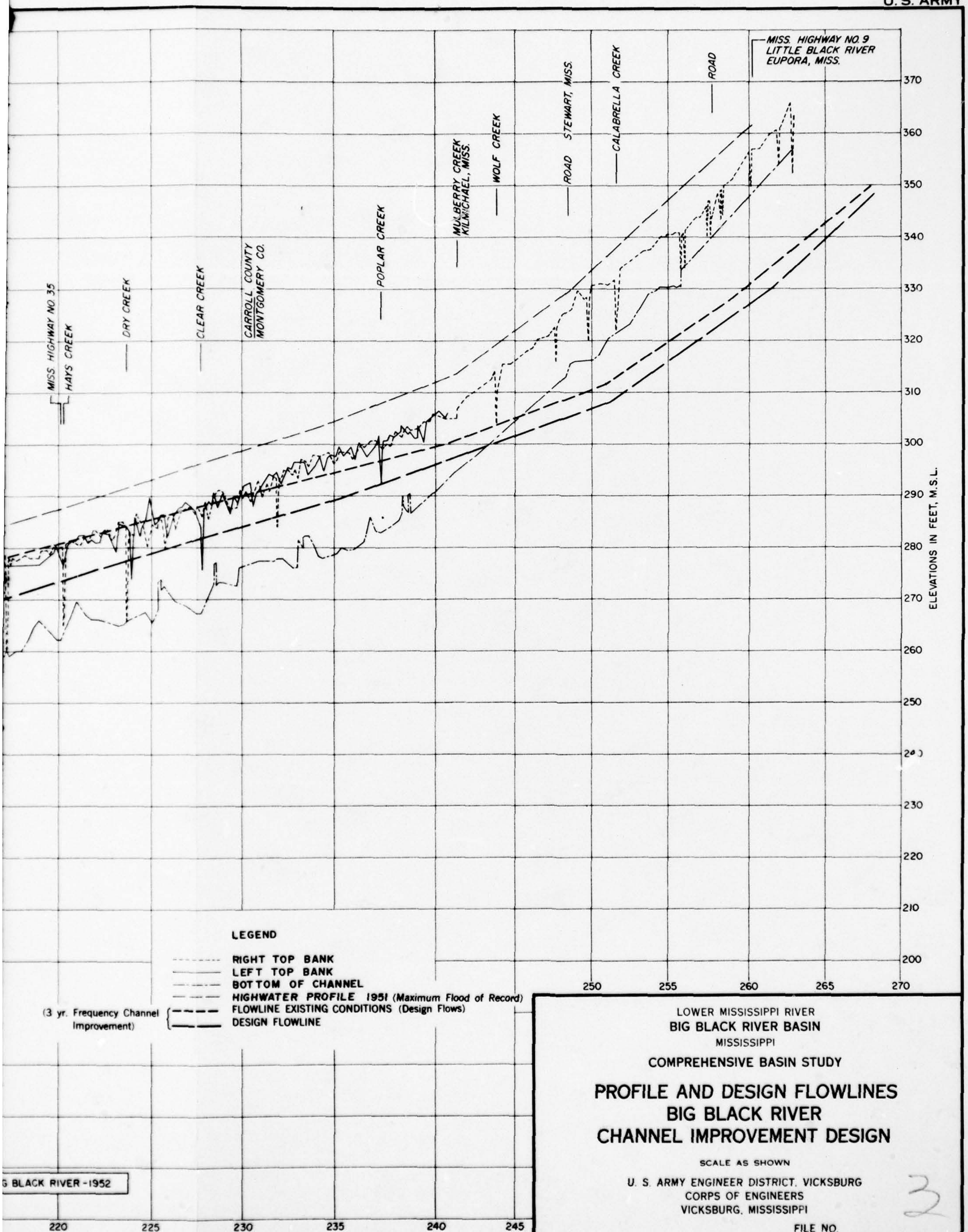
PLATE 5


ELEVATIONS IN FEET, M.S.L.
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
130
135
140
145
150
155
160
165
170
175
180
185
PANTHER CREEK
MISS. HIGHWAY NO 16
DOAKS CREEK
ILL. CEN. R.R.
BIG CYPRESS CREEK
INTERSTATE HWY. NO. I-55
U.S. HIGHWAY NO. 51
PICKENS, MISS.
SENEATCHA CREEK
GOODMAN, MISS.
ILL. CEN. R.R.



GOODMAN, MISS.
ILL. CEN. R.R.
MISS. HIGHWAY NO. 12 DURANT, MISS.
INDIAN CREEK
APOOKTA CREEK
JORDAN CREEK
WEST, MISS.
ZILPHA CREEK
PEACHAHALA CREEK
MISS. HIGHWAY NO. 35
HAYS CREEK
DRY CREEK
CLEAR CREEK
CARROLL COUNTY
MONTGOMERY CO.
LEGEND
RIGHT TOP BANK
LEFT TOP BANK
BOTTOM OF CHANNEL
HIGHWATER PROFILE 195
(3 yr. Frequency Channel Improvement)
FLOWLINE EXISTING CONDITION
DESIGN FLOWLINE
DISTANCE IN MILES ABOVE MOUTH OF BIG BLACK RIVER - 1952
2
175
180
185
190
195
200
205
210
215
220
225
230
235

U.S. ARMY



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI

COMPREHENSIVE BASIN STUDY

PROFILE AND DESIGN FLOWLINES
BIG BLACK RIVER
CHANNEL IMPROVEMENT DESIGN

SCALE AS SHOWN

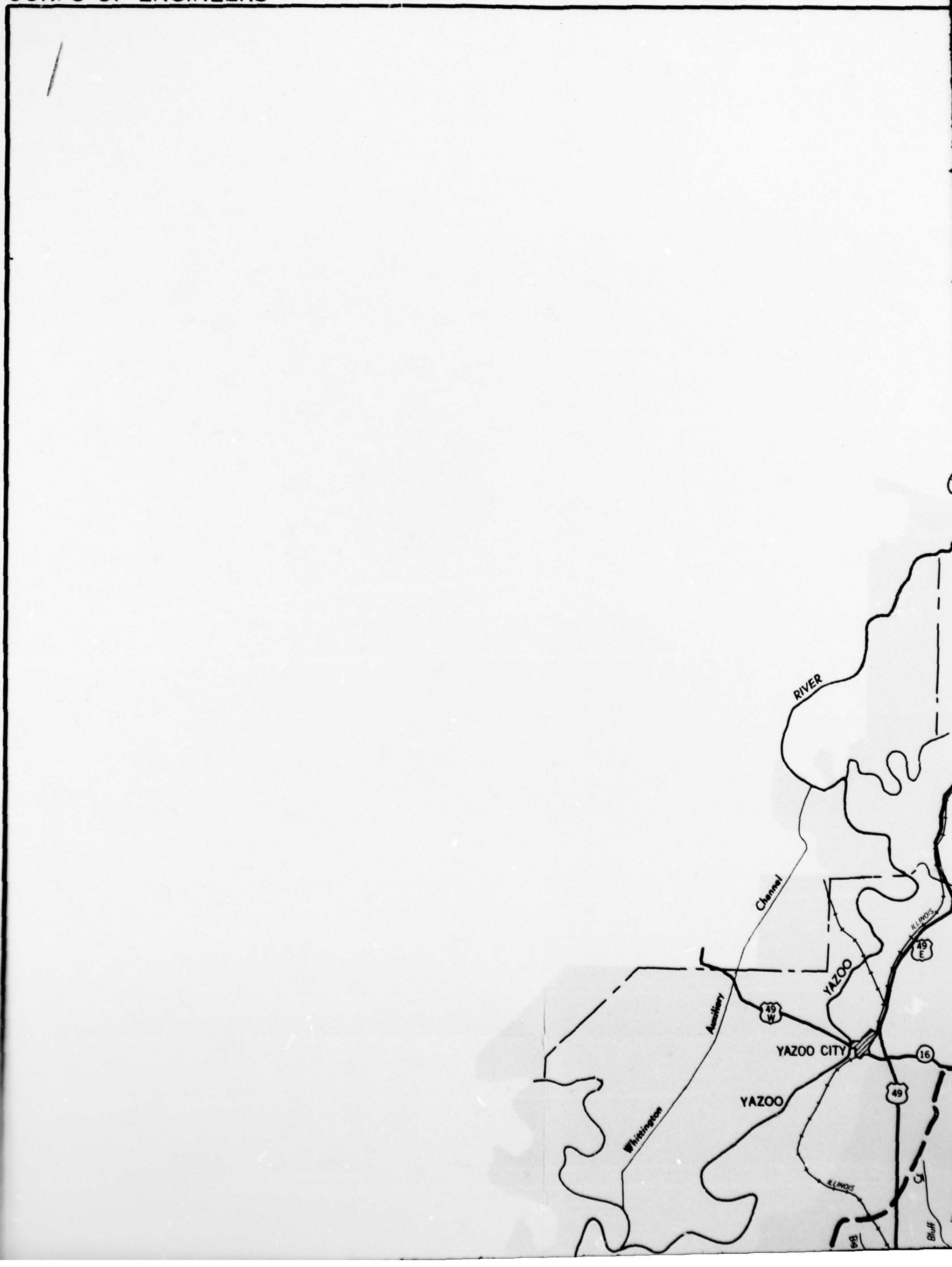
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

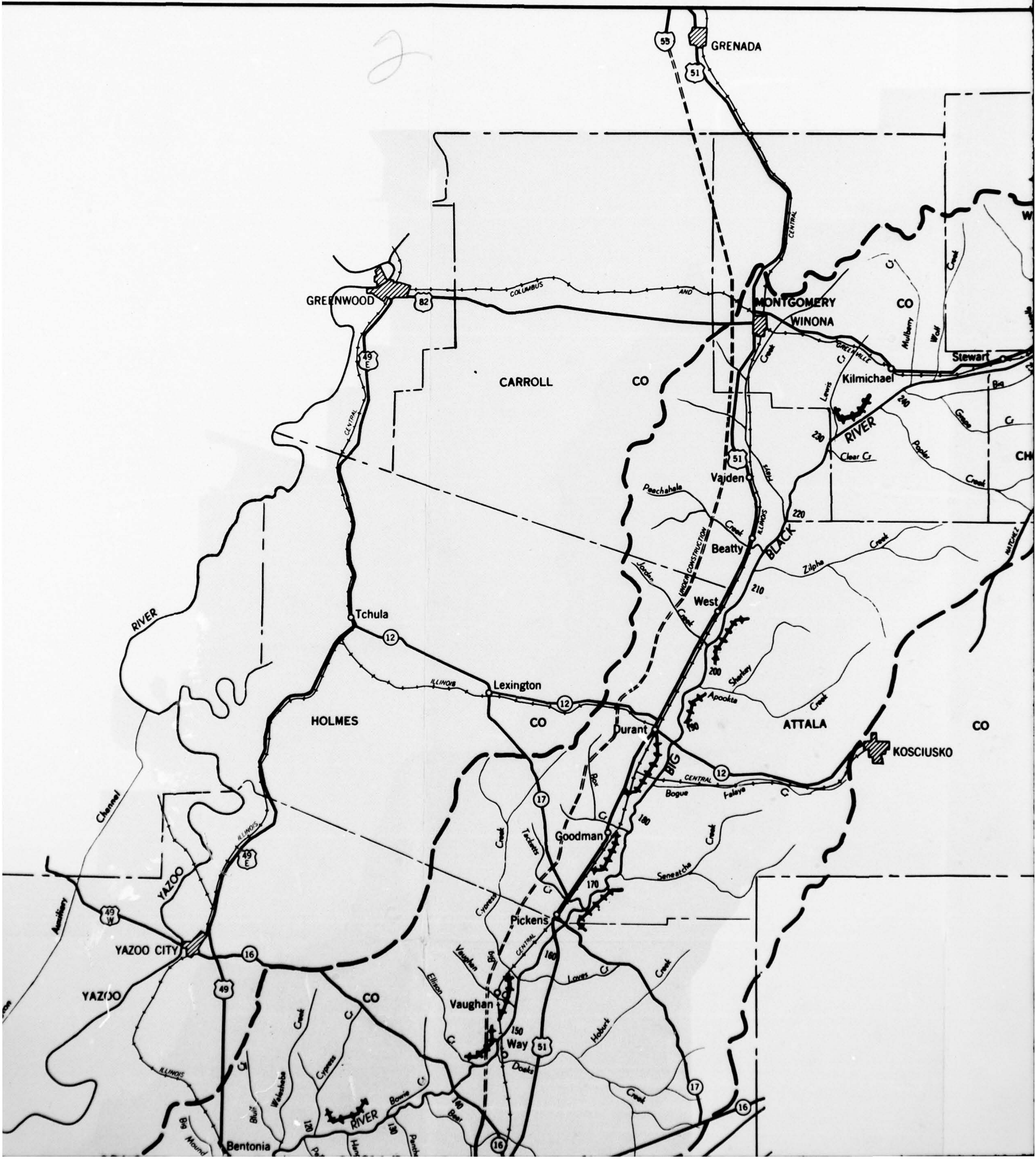
FILE NO.

3

PLATE 6

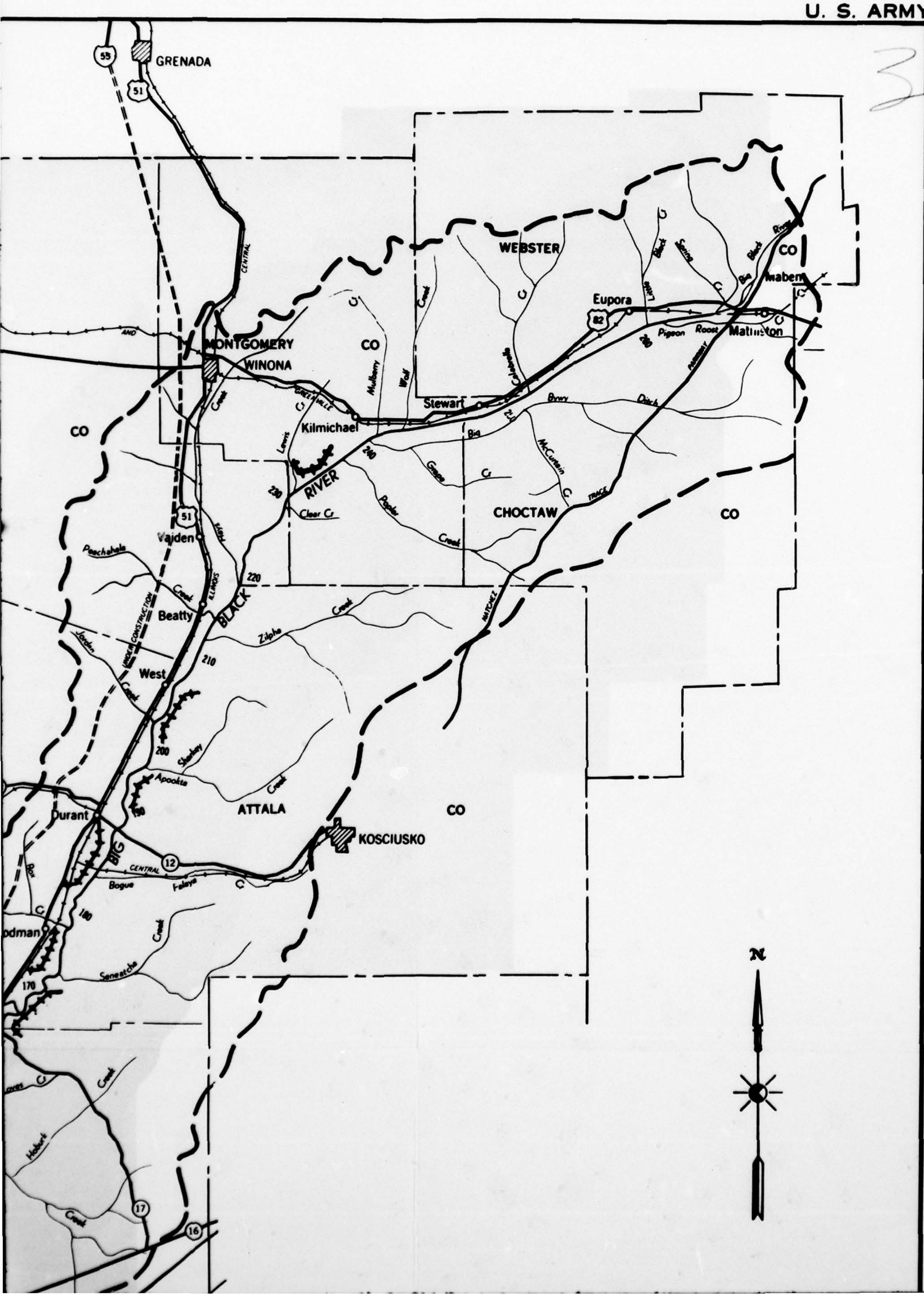
CORPS OF ENGINEERS

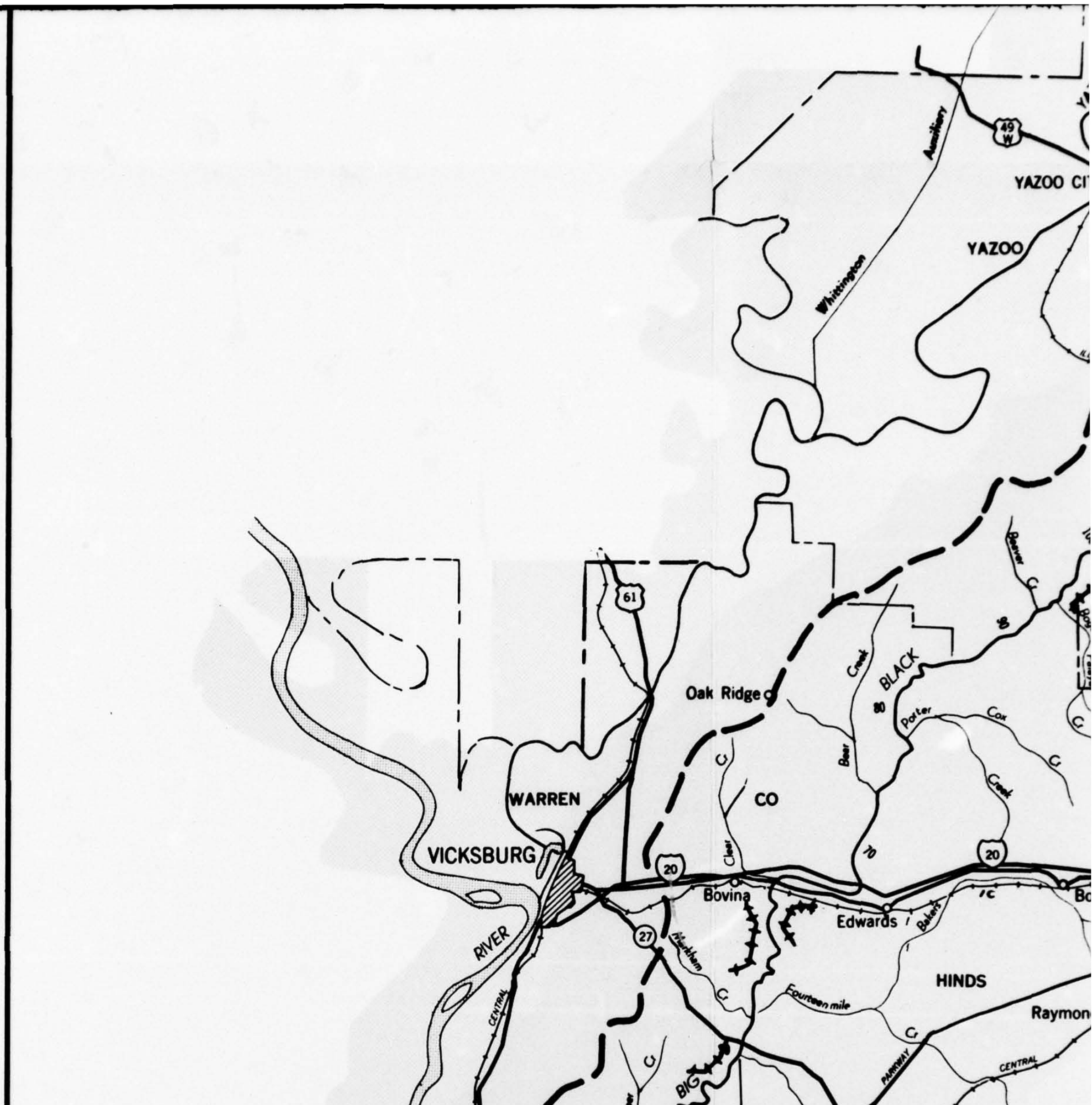




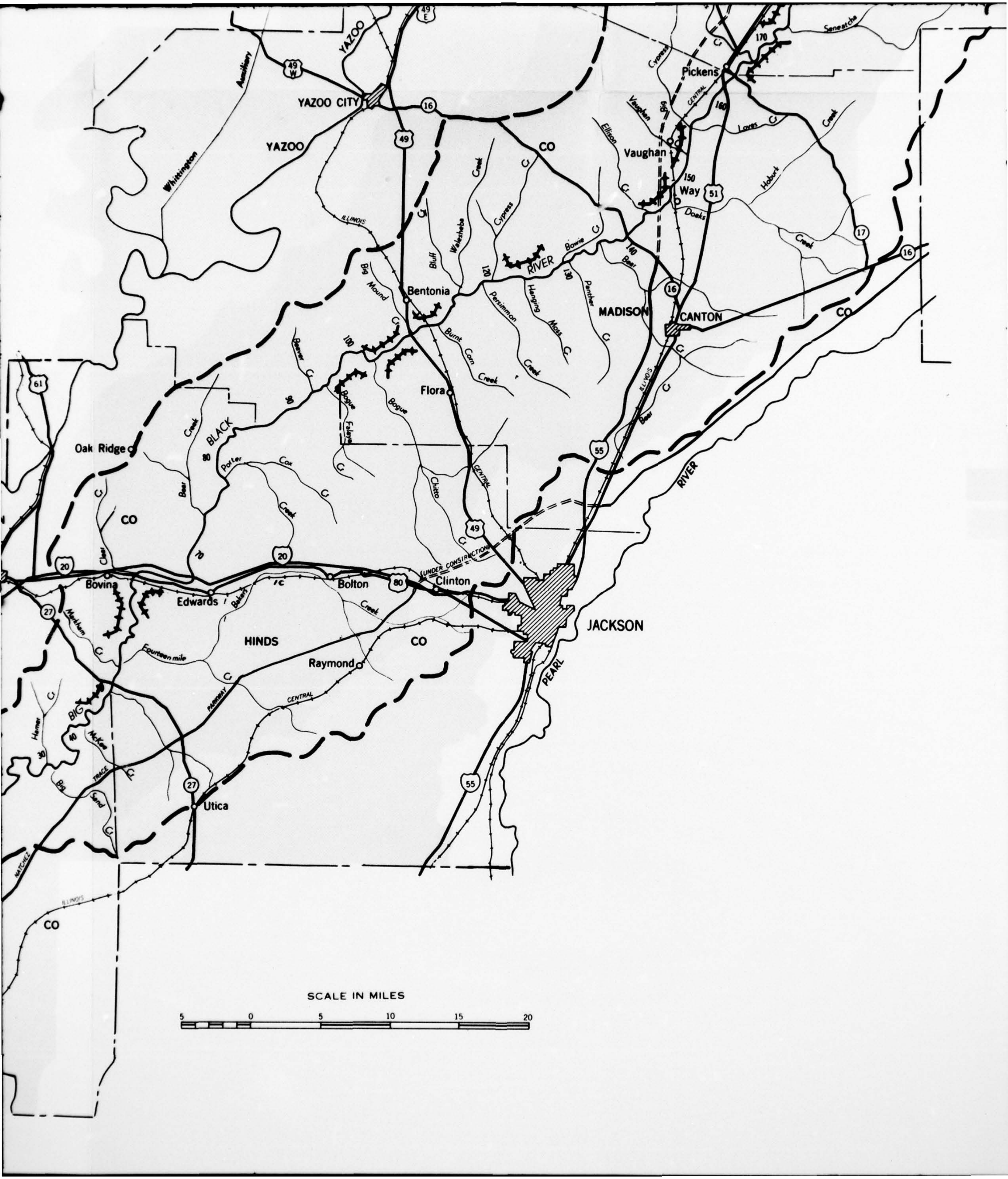
GRENADA
55
51
GREENWOOD
82
COLUMBUS
AND
GREENVILLE
CENTRAL
MONTGOMERY
CO
WINONA
Stewart
Kilmichael
CARROLL
CO
49 E
Lewis
Mulberry
Wolf
Creek
Cr
Big
240
230
RIVER
Green
Cr
Clear Cr
Poplar
Creek
51
Vaiden
Hays
Creek
Peachahala
Creek
ILLINOIS
220
Beatty
BLACK
Zilpha
Creek
NATCHEZ
Jordan
Creek
UNDER CONSTRUCTION
West
210
RIVER
Tchula
12
200
Sharkey
Creek
Apookta
Lexington
12
HOLMES
CO
Durant
190
ATTALA
CO
BIG
KOSCIUSKO
12
CENTRAL
Bogue
Falaya
Box
Channel
Goodman
180
Creek
Creek
Tacketts
17
ILLINOIS
49 E
YAZOO
Seneatcha
Cr
170
Auxiliary
49 W
Cypress
Pickens
YAZOO CITY
16
CENTRAL
160
Vaughan
Big
Loves Cr
Creek
YAZOO
49
CO
Ellison
Vaughan
Creek
Cr
150
Way
51
Hoburk
Cr
Cypress
Doaks
ILLINOIS
Wolf
Creek
17
Bowie Cr
140
16
Bluff
Big Mound
Bear
RIVER
120
130
Bentonia
16

U. S. ARMY

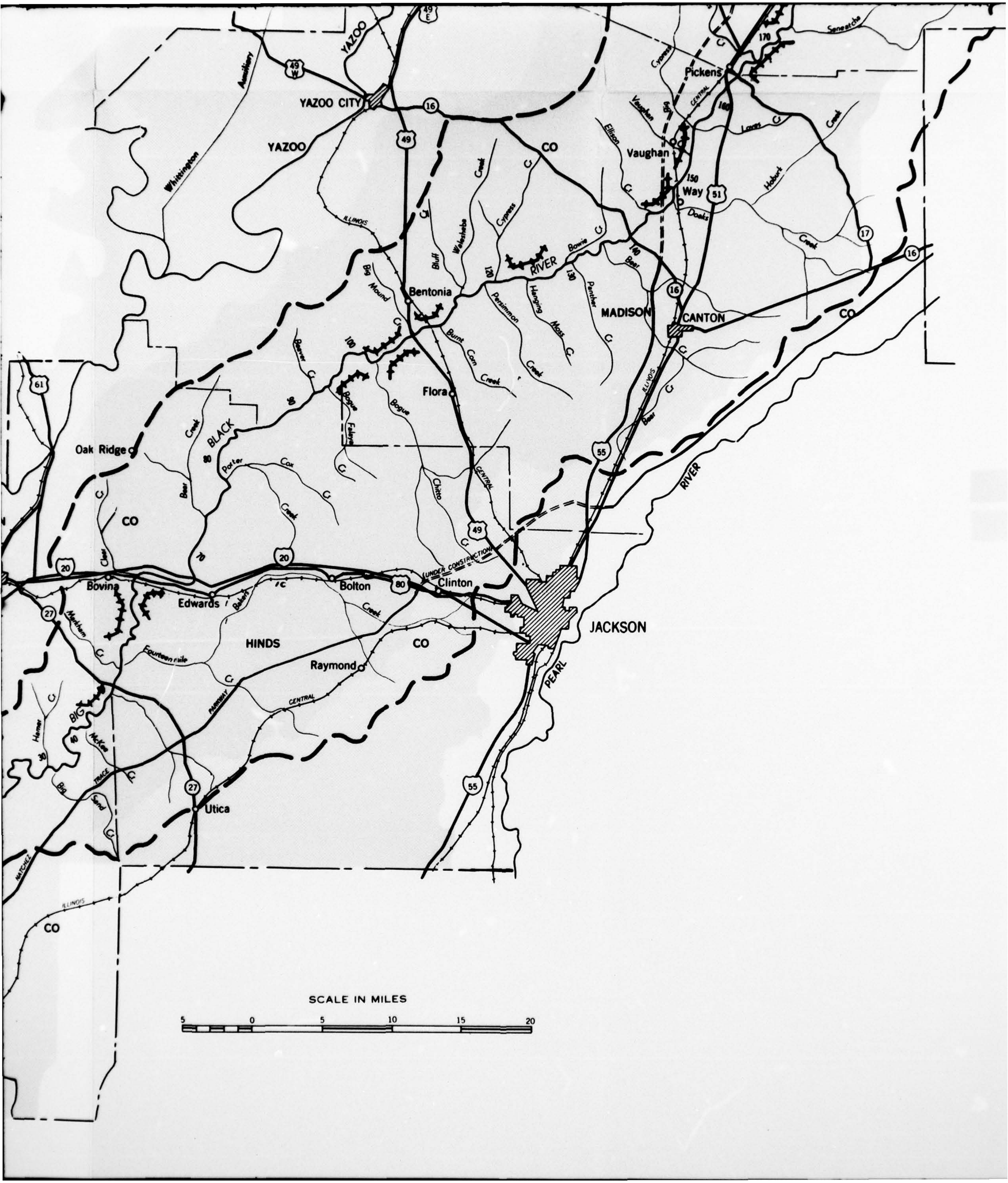

GRENADA
WEBSTER
CO
Eupora
Mabens
Mathiston
MONTGOMERY
WINONA
CO
Stewart
Kilmichael
CO
RIVER
CHOCTAW
CO
Vaiden
Beatty
BLACK
West
Durant
ATTALA
CO
KOSCIUSKO
BIG
CENTRAL
Bogue
Falaya
Seneatcha
Peachahala
Zilpha
Apookta
Pigeon
Roost
Big
Black
River
Clear Cr
Poplar
Creek
McCurtain
Mulberry
Wolf
Creek
Lewis
Hobuck
Creek



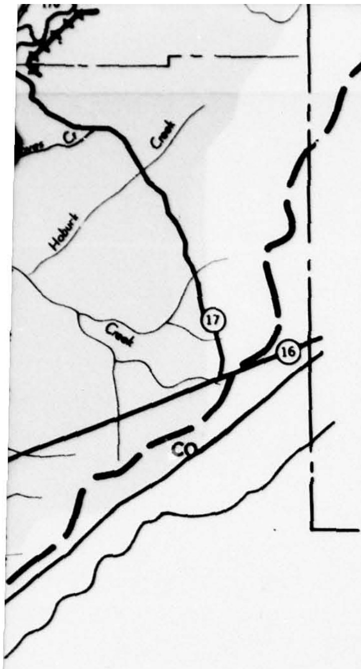
YAZOO
Whittington
Auxiliary
Oak Ridge
BLACK
Bear
Porter
Cox
Creek
CO
WARREN
VICKSBURG
Bovina
Edwards
Bakers
HINDS
Fourteen mile
RIVER
CENTRAL
PARKWAY
BIG
Hamer
McKee
Yokena
TRACE
Big
Sand
Utica
Kennison
ILLINOIS
NATCHEZ
Grand Gulf
MISSISSIPPI
CLAIBORNE
Port Gibson
CO
SCALE
5
0
5



YAZOO CITY
YAZOO
CO
Pickens
Vaughan
Way
Bentonia
Flora
MADISON
CANTON
CO
Oak Ridge
CO
Bovina
Edwards
Bolton
Clinton
JACKSON
HINDS
CO
Raymond
Utica
CO
YAZOO
BLACK
RIVER
PEARL
RIVER
UNDER CONSTRUCTION
ILLINOIS
CENTRAL
NATCHEZ
TRACE
PARKWAY
Whittington
Auxiliary
Big
Mound
Bluff
Wolatcheba
Cypress
Creek
Bowie
Persimmon
Hanging
Moss
Panther
Bear
Burnt
Corn
Creek
Beaver
Bogue
Phalia
Porter
Cox
Chitto
Bakers
Fourteen mile
Clear
Big
Black
Hamer
McKee
Sand
Ellison
Vaughan
Cypress
Loves
Hobuck
Doaks
Senatcha
SCALE IN MILES
5 0 5 10 15 20



YAZOO CITY
YAZOO
CO
Pickens
Vaughan
Way
Bentonia
MADISON
CANTON
Flora
Oak Ridge
CO
BLACK
RIVER
Bovina
Edwards
Bolton
Clinton
JACKSON
HINDS
CO
Raymond
Utica
PEARL
RIVER
CO
UNDER CONSTRUCTION
ILLINOIS
CENTRAL
NATCHEZ
TRACE
PARKWAY
Whittington
Auxiliary
Big Mound
Bluff
Walesheba
Creek
Cypress
Bowie
Hanging
Moss
Persimmon
Panther
Burnt
Corn
Creek
Bogue
Falaya
Beaver
Bear
Porter
Cox
Chitto
Clear
Baker's
Fourteen mile
Big
McKee
Hamer
Big Sand
Ellison
Vaughan
Big
Cypress
Loves
Hobuck
Doaks
Seneatche
Bear
SCALE IN MILES
5 0 5 10 15 20



LEGEND

Drainage Area

Base Study Area

Miles Above Mouth

Levee

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

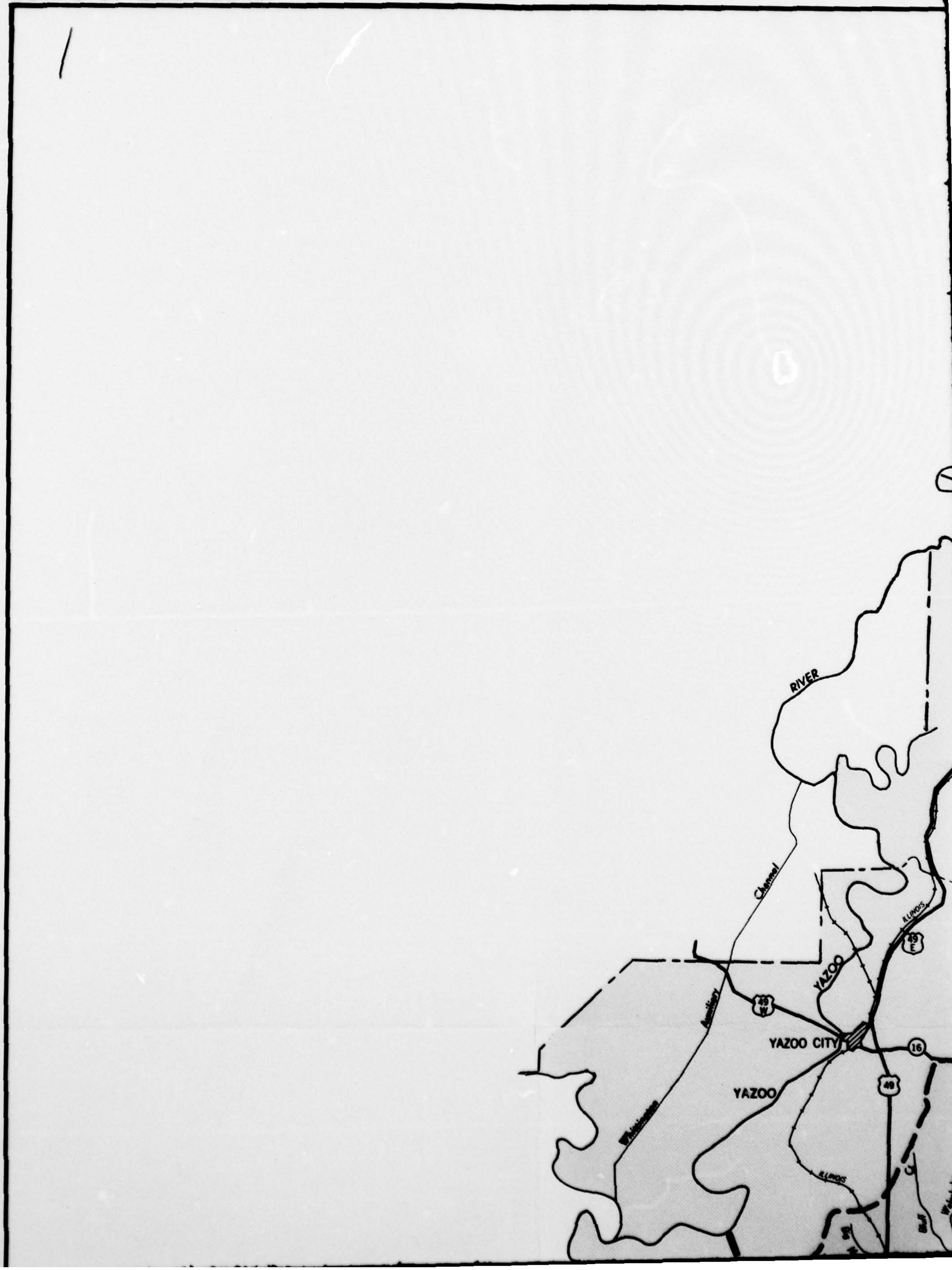
LOCAL PROTECTION PROJECTS
(LOOP LEVEES)

SCALE AS SHOWN

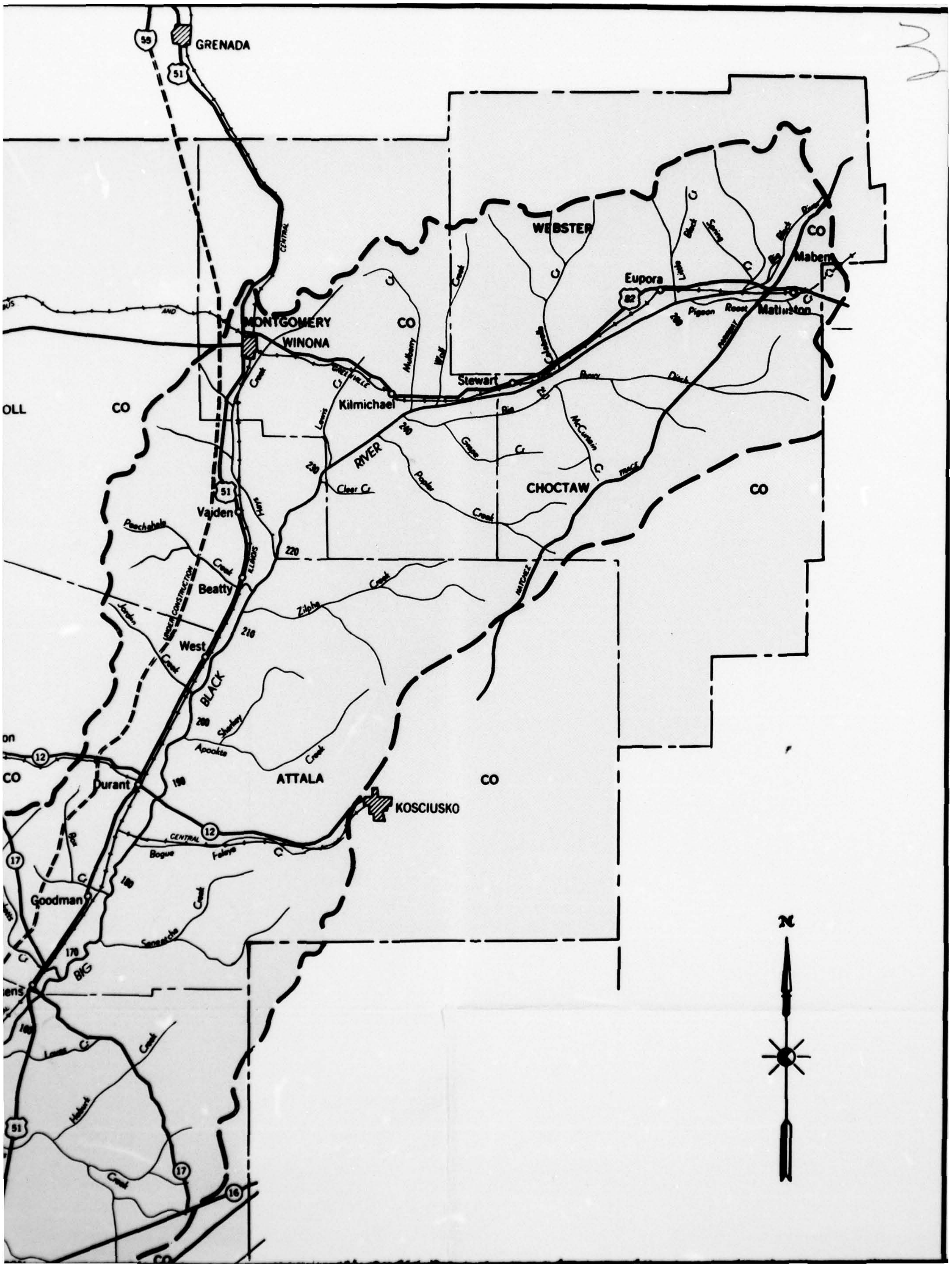
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

CORPS OF ENGINEERS



GRENADA
GREENWOOD
MONTGOMERY CO
WINONA
Kilmichael
Stewart
CARROLL CO
Vaiden
Beatty
West
Tchula
Lexington
HOLMES CO
Durant
ATTALA CO
KOSCIUSKO
Goodman
Pickens
YAZOO CITY
YAZOO CO
Vaughan
Way
RIVER
BLACK
BIG
YAZOO
UNDER CONSTRUCTION
COLUMBUS AND GREENVILLE
CENTRAL
ILLINOIS
Peachahala Creek
Zilpha Creek
Apookta Creek
Bogue Faleya C.
Senasacha Creek
Jordan Creek
Clear Cr.
Poplar Creek
Lewis Cr.
Mulberry
Big Black River
Cypress Cr.
Ellison Cr.
Vaughan
Bowie Cr.
Cypress C.
Wolf Creek
Hobuck
Channel
Whittington
Auxiliary
Tackett
Doaks
Box
Lane Cr.
Creek
Cr.
Big
Bull
Wahalak



3
GRENADA
55
51
WEBSTER
CO
Eupora
82
Pigeon
Roost
Mathiston
MONTGOMERY
CO
WINONA
Stewart
Kilmichael
OLL
CO
RIVER
200
230
Clear Cr
Poplar
Creek
CHOCTAW
CO
Vaiden
51
Creek
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Beatty
Zilpha
Creek
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West
BLACK
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Apookta
Creek
ATTALA
CO
Durant
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KOSCIUSKO
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CENTRAL
Bogue
Faleya
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Creek
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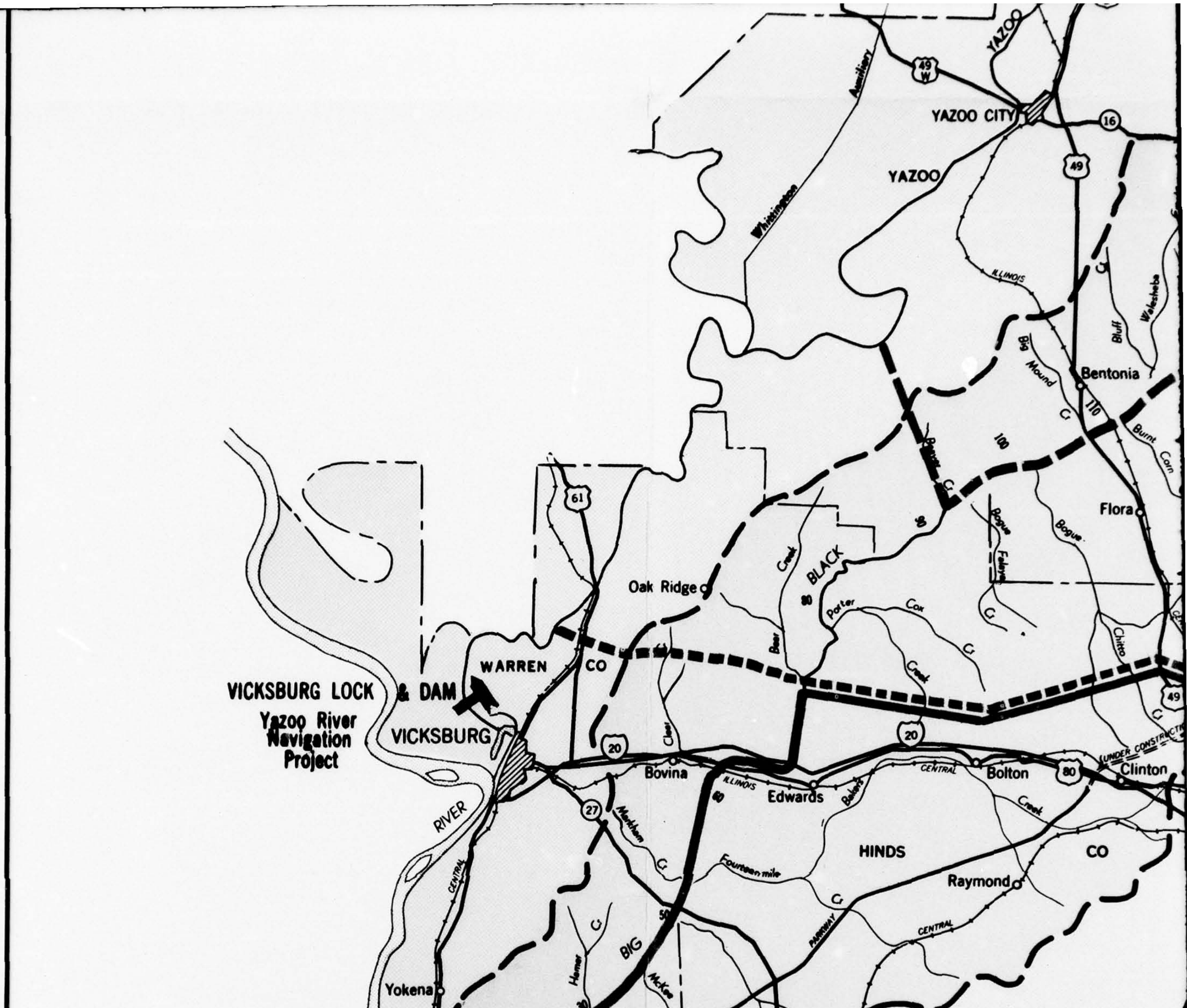
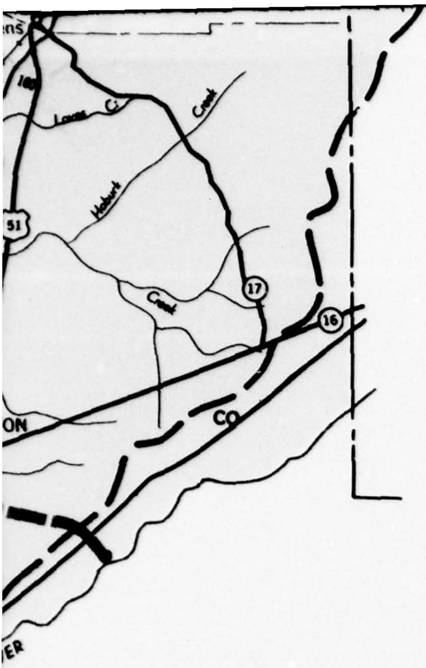
Creek
16
CO



VICKSBURG LOCK & DAM
Yazoo River
Navigation
Project
VICKSBURG
WARREN CO
YAZOO CITY
YAZOO
Bentonia
Flora
Oak Ridge
BLACK
Bovina
Edwards
Bolton
Clinton
HINDS CO
Raymond
Yokena
BIG
Utica
Grand Gulf
CLAIBORNE CO
Port Gibson
MISSISSIPPI
RIVER
UNDER CONSTRUCTION
SCALE IN MILES
5 0 5 10 15

YAZOO CITY
YAZOO
Pickens
BIG
Vaughan
Way
CO
Bentonia
RIVER
MADISON
CANTON
Flora
JACKSON
PEARL
RIVER
Bolton
Clinton
Raymond
UNDER CONSTRUCTION
ILLINOIS
CENTRAL
LEGEND
Drainage Area
Base Study Area
Miles Above Mouth
Navigation Routes - Jack
SCALE IN MILES
0
5
10
15
20



LEGEND

Drainage Area

Base Study Area

Miles Above Mouth

Navigation Routes - Jackson Miss. to Miss. River

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

PLANS CONSIDERED
NAVIGATION ROUTES

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

PLATE 8

6

APPENDIX A
BIG BLACK RIVER BASIN
HYDROLOGY AND HYDRAULICS

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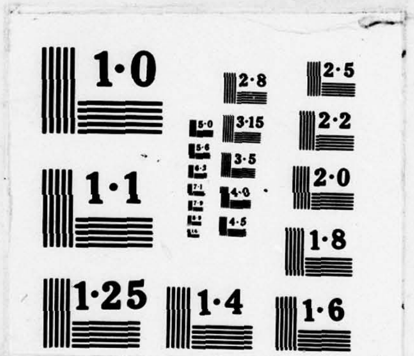
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APPENDIX A

BIG BLACK RIVER BASIN
HYDROLOGY AND HYDRAULICS

1. INTRODUCTION

General. The principal objectives of the hydraulics and hydrology appendix to the Big Black River Basin Report are to present methods used to evaluate the effects of small reservoirs and channel improvement works on lowering main stream stages, and to provide such basic data as necessary to formulate a feasible plan of basin development.

2. DRAINAGE BASIN CHARACTERISTICS

a. Description of the area. The Big Black River Basin lies entirely in the State of Mississippi with its source in Webster County about 12 miles northeast of Eupora, Mississippi. It extends some 270 miles in a southwesterly direction, entering the Mississippi River about 27 miles below Vicksburg, Mississippi, near Grand Gulf, Mississippi. The drainage area of the Big Black River is approximately 155 miles in length and has an average width of 22 miles. The uplands are rolling and rise from flat wooded areas adjacent to the river, to a secondary bottom land shelf at a higher elevation; and then to the hill line. Water surface slopes of the river vary from 2.5 feet per mile in the upper portion of the area to about 1.0 foot per mile in the lower portion. Tributaries throughout the basin are numerous and rather small with drainage areas up to about 200 square miles. They have steep slopes and rapid runoff. Bottom lands in the upper and central portions of the basin are overflowed from headwater runoff, while the extreme lower portions are overflowed from both headwater runoff and backwater from the Mississippi River.

b. Climate. The climate of the area is generally mile, with an average temperature of about 64° F. Average monthly temperatures range from about 50° F. in the winter to 80° F. in the summer. The maximum observed temperature in the area was 115° F. in July 1930, and the minimum was -16° F. in February 1951.

c. Precipitation.

(1) The annual rainfall in the general area has ranged from a maximum of 84 inches in 1880 to a minimum of 26 inches in 1936, with an average amount of 52 inches. Monthly rainfall varies from about 2.1 inches in October to 5.6 inches in March, and averages nearly 5 inches per month from November through May. Monthly rainfall data for Pickens, Mississippi, shown below, are indicative of the rainfalls which have occurred in the area.

PICKENS, MISSISSIPPI
MONTHLY RAINFALL DATA (1)
1948-1964

Month	Average	Maximum	Minimum	Month	Average	Maximum	Minimum
January	5.8	12.1	1.9	July	4.7	8.8	2.6
February	5.2	13.0	2.4	August	2.7	7.3	0.9
March	6.4	13.3	4.0	September	3.2	7.7	0.1
April	5.4	10.3	1.2	October	2.0	5.1	0.0
May	4.9	8.1	0.3	November	4.5	13.2	0.1
June	3.6	9.7	0.7	December	4.5	7.6	1.6
Annual	52.9	66.4	38.4				

(1) Observed rainfall in inches

(2) Snowfall is generally light, averaging about 2 inches annually and rarely lasts longer than a few days. Rainfall records show that storm rainfall with the greatest intensities occur during the winter and early spring, but may occur in any month. Precipitation data for reporting stations in and adjacent to the basin are shown on Table A-1.

d. Runoff. Runoff from the area varies from about 10 percent of rainfall in the summer to about 85 percent in the winter and early spring, depending on antecedent conditions, and intensity of rainfall. Annual runoff from the area averages about 17 inches. Infiltration rates were computed at selected gaging stations and varied from .01 to .09 inches per hour.

e. Streamflow records. Main stream gages have been maintained at Kilmichael, West, Pickens, Bentonia, and Bovina, Mississippi, for a number of years. Stations at Pickens and Bovina, Mississippi, are maintained by the U. S. Geological Survey. Table A-2 shows stage and discharge data for all gages in the Big Black River Basin. Records show that maximum stages of record at four of the five main stream stations occurred in 1951. The maximum stage of record at Bovina, Mississippi, occurred in 1961.

f. Floods. Major floods occurred in 1927, 1930, 1944, 1946, 1949, 1951, 1958, and 1961. Three of the more recent floods are described briefly in the following paragraphs:

(1) The 1951 flood resulted from the heavy rainfall of 27 March through 19 April 1951, when 12.6 inches and 13.5 inches of rainfall were measured at Vaiden and Germania, Mississippi, respectively. Average storm rainfalls over the area ranged from 5 to 13 inches. This storm produced maximum stages of record at all main stream gaging stations with the exception of Bovina in the lower portion of the

APPENDIX A

TABLE A-1
PRECIPITATION DATA

Station	Type of gage	Elevation ft, msl	Record			Normal annual precip.	Maximum				Minimum			
			From	To	No. of years		Yearly		Monthly		Yearly		Monthly	
							Year	Inches	Month and year	Inches	Year	Inches	Month and year	Inches
Ackerman	NR[1]	520	1940	1965	24	-	1961	69.55	Jan 1949	14.92	1943	31.61	Oct 1963	0.02
Black Hawk	NR	335	1951	1965	15	-	1961	66.52	Mar 1951	12.50	1952	38.50	Oct 1963	0
Canton	NR	228	1882	1965	83	50.31	1961	69.47	May 1909	18.28	1924	28.76	Var. yrs.	0
Calhoun City	R[2]	-	1944	1965	22	-	1957	71.80	Apr 1964	14.45	1965	29.65	Oct 1963	T
Edinburg	NR	-	1908	1965	58	53.45	1932	78.61	Dec 1932	17.44	1943	33.64	Nov 1924	T
Eupora	R	428	1927	1965	39	51.36	1932	69.61	May 1930	19.10	1952	33.59	Jun 1929	0
Germania	NR	150	1947	1965	18	-	1961	65.10	Mar 1951	14.42	1963	33.19	Oct 1963	T
Goshen Springs	NR	322	1946	1965	17	-	1964	66.87	Nov 1948	18.15	1952	31.23	Oct 1952	0.02
Houston	R	-	1940	1965	24	-	1957	71.23	Jan 1949	16.03	1942	34.97	Oct 1963	0
Jackson	R	305	1882	1965	81	49.33	1923	72.75	Apr 1874	23.80	1952	31.66	Oct 1963	0
Kosciusko	NR	468	1890	1965	76	53.07	1891	73.70	Mar 1891	15.50	1952	30.51	Var. yrs.	0
Lexington	R	310	1943	1965	23	-	1961	66.12	Nov 1948	14.80	1952	34.55	Var. yrs.	0
Oakley	NR	205	1948	1965	17	-	1964	71.41	Mar 1949	12.22	1963	35.49	Sep 1956	0
Ofahoma	NR	348	1940	1965	26	-	1961	68.38	Nov 1948	13.82	1952	33.32	Var. yrs.	0
Pickens	NR	222	1948	1965	18	-	1961	66.38	Dec 1961	14.49	1963	37.36	Oct 1963	0
Port Gibson	NR	160	1885	1965	80	56.12	1923	78.15	May 1909	17.11	1924	35.09	Var. yrs.	T
Utica	NR	-	1903	1965	62	52.80	1923	73.35	Nov 1948	15.45	1924	32.83	Var. yrs.	0
Vaiden	NR	389	1948	1965	18	-	1961	74.92	Nov 1948	14.23	1952	37.47	Var. yrs.	0
Vicksburg	R	234	1871	1965	94	49.50	1880	84.22	Apr 1874	22.24	1924	31.20	Var. yrs.	0
Winona	NR	390	1953	1965	13	-	1961	67.32	Nov 1957	13.92	1963	35.40	Sep 1954	0.29
Yazoo City	R	107	1886	1965	80	50.24	1923	71.85	May 1909	19.24	1936	25.97	Var. yrs.	0
Zama	NR	-	1948	1957	9	-	1956	51.87	Feb 1956	9.87	1952	31.61	Oct 1952	0

1/ Non-recording

2/ Recording

Stream and Location	Type of Gage	Agency	D.A.	Zero of Gage	Period of Record From	To
Big Black River at Kilmichael	R	C.E.	549	296.55	7/21/36	3/28/6
Big Black River at West	R	C.E.	985	249.74	7/21/36	1965
Big Black River at Pickens	R	U.S.G.S.	1,460	196.26	7/21/36	1965
Big Black River at Ragin	WW	C.E.	2,320	130.18	3/26/29 1/28/32	10/1/3 9/26/4
Big Black River at Bentonia	R	C.E.	2,340	130.18	10/4/47	1965
Big Black River at Bovina	R	U.S.G.S. 3/	2,810	84.93	1/2/36	1965
Big Black River at Hankinson	WW	C.E.		48.42	7/22/36	12/10/
Mulberry Creek at Kilmichael	R	C.E.	40	296.85	10/23/45	8/11/5
Zilpha Creek near Kosciusko	C.S.	U.S.G.S.	90	-	1953	1965
Doaks Creek near Canton	C.S.	U.S.G.S.	161	-	1948	1965
Bear Creek near Canton	R C.S. C.S.	C.E. C.E. C.E.	154 154	176.62	8/31/49 1958 1949	12/14/ 1965 1965
Bear Creek near Canton (Hwy 51)	C.S.	C.E.	86.0	-	1951	1965
Bear Creek near Madison	C.S.	U.S.G.S. C.E.	24.2	-	1948 1951	1955 1965
Tilda Bogue near Canton	C.S.	U.S.G.S.	19.2	-	1948	1965
Bachelor Creek near Canton	C.S.	U.S.G.S.	3.11	-	1953	1965
Bogue Chitto near Flora	C.S.	U.S.G.S.	127.0	-	1953	1965
Clear Creek near Bovina	C.S.	U.S.G.S.	Est. 36.0	-	1953	1965
Fleetwood Creek near Bolton	C.S.	U.S.G.S.	-	-	1960	1965
Unnamed Creek near Bolton	C.S.	U.S.G.S.	-	-	1952 1960	1953 1965

1/ Peak discharge from crest stage gage.

2/ And other dates.

3/ Jan. 7, 1936 - Sep. 1938 from C.E. records.

4/ Measured flow.

APPENDIX A

TABLE A-2
STAGE AND DISCHARGE DATA

	Zero of Gage	Gage: Period of Record: From	To	Maximum: Stage	Maximum: Date	Minimum: Stage	Minimum: Date	Disc[harge]: Period of Record: From	To	Maxim[um]: cfs	CFSM
	296.55	7/21/36	3/28/60	17.23	3/29/51	0.3	7/30/36	Aug 36	Dec 46	37,300 4/	68
	249.74	7/21/36	1965	24.09	3/30/51	0.38	9/22-23/56	Aug 36	Dec 46	47,000	48
	196.26	7/21/36	1965	23.7 HWM	12/29/26	1.38	10/5,8,9/54	Aug 36	1965	49,400	34
	130.18	3/26/29	10/1/31	34.7	5/23/30	10.3	10/11/46	Feb 29	Sep 31	-	-
		1/28/32	9/26/48					Jan 36	Dec 47		
	130.18	10/4/47	1965	31.64	3/30/51	5.56	11/1/63	Jan 48	Sep 53	66,500	28
	84.93	1/2/36	1965	40.53	12/20/61	5.99	9/30-10/2/54	Jan 36	1965	63,500	23
	48.42	7/22/36	12/10/46	42.2	2/21-22/37	-1.5	11/4-7/39	-	-	-	-
	296.85	10/23/45	8/11/53	16.45	3/29/51	0.6	2/18-19/47	Oct 45	Dec 46	-	-
	-	1953	1965	27.49	4/13/55	-	-	-	-	16,000 1/	-
	-	1948	1965	18.46	1/7/51	-	-	-	-	12,600 1/	-
	176.62	8/31/49	12/14/57	19.49	4/30/53	2.90	9/3/49 2/	-	-	-	-
		1958	1965	196.4	Jan. 62	-	-	-	-	-	-
		1949	1965	215.63	2/9/62	-	-	-	-	-	-
.0	-	1951	1965	222.22	4/30/53	-	-	-	-	7,300 1/	
.2	-	1948	1955	16.04	4/29/53	-	-	-	-	7,300 1/	
		1951	1965	254.86	2/9/62	-	-	-	-	-	-
.2	-	1948	1965	19.00	4/29/53	-	-	-	-	8,800 1/	-
.11	-	1953	1965	17.78	4/29/53	-	-	-	-	991 1/	-
.0	-	1953	1965	20.88	4/30/53	-	-	-	-	21,000 1/	-
.0	-	1953	1965	29.53	4/11/62	-	-	-	-	18,000 1/	-
	-	1960	1965	23.49	8/22/60	-	-	-	-	4,400 1/	-
	-	1952	1953	97.75	1953	-	-	-	-	860 1/	-
		1960	1965	97.04	8/22/60						

	Period of Record		Discharge						Mean Annual
			Maximum			Minimum			
	From	To	cfs	CFSM	Date	cfs	CFSM	Date	
	Aug 36	Dec 46	37,300 4/	68	3/29/51	5 4/	.009	8/15/56	614
'56	Aug 36	Dec 46	47,000	48	3/30/51	21 4/	.021	10/21/52	1,290
/54	Aug 36	1965	49,400	34	3/28/51	27	.018	8/31-9/1/43	1,809
)	Feb 29 Jan 36	Sep 31 Dec 47	-	-	-	-	-	-	-
	Jan 48	Sep 53	66,500	28	3/30/51	39	.017	8/16/30	2,870
'2/54	Jan 36	1965	63,500	23	12/20/61	65	.023	10/2/54	3,340
9	-	-	-	-	-	-	-	-	-
'47	Oct 45	Dec 46	-	-	-	-	-	-	-
	-	-	16,000 1/	-	4/13/55	-	-	-	-
	-	-	12,600 1/	-	1/7/51	-	-	-	-
!/	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
	-	-	7,300 1/		4/30/53	-	-	-	-
	-	-	7,300 1/		4/29/53	-	-	-	-
	-	-	-	-	-	-	-	-	-
	-	-	8,800 1/	-	4/29/53	-	-	-	-
	-	-	991 1/	-	4/29/53	-	-	-	-
	-	-	21,000 1/	-	4/30/53	-	-	-	-
	-	-	18,000 1/	-	4/11/62	-	-	-	-
	-	-	4,400 1/	-	8/22/60	-	-	-	-
	-	-	860 1/	-	8/22/60	-	-	-	-

3

basin. Since this flood produced maximum stages of record at most stations, it was selected as the basic flood for this study.

(2) The 1958 flood was produced by storm rainfall of 24 April through 6 May, which measured 11.0 inches at Vaiden, Mississippi, and 10.8 inches at Canton, Mississippi. This flood produced the third largest peak stages and flows of record for the lower half of the basin.

(3) The December 1961 flood resulted from rainfall which occurred from 4-18 December, with measured amounts of 12.4 inches and 13.9 inches at Canton and Germania, Mississippi, respectively. This storm produced general heavy rainfalls throughout the entire basin, averaging in excess of 10 inches over the drainage area. The second largest peak flows and stages of record were observed throughout the basin as a result of this storm, with the exception of Bovina, Mississippi, where it produced the maximum of record. The 1961 storm rainfall was about the same magnitude as the March-April 1951 storm, with observed peak flows and stages only slightly lower. At Bovina, Mississippi, floods similar to the 1961 flood have a recurrence of about once in 50 years, as compared to the 1951 flood magnitude which could occur about once every 15 years. For reaches above Bovina, Mississippi, recurrence intervals average about once in 15 years for floods comparable to the 1961 magnitude, and about once in 20 years for floods of the 1951 magnitude.

3. BASIC HYDRAULICS

a. Unit hydrographs. Unit hydrographs were derived from observed flows at Kilmichael and West on the main stem of the Big Black River and Bear Creek near Canton, Mississippi, for selected storms, in accordance with procedure outlined in EM 1110-2-1405, "Flood-Hydrograph Analysis and Computations," dated 31 August 1959. When comparing coefficients from these studies with Snyder's coefficients Ct and Cp 640, indications were that these areas have flatter slopes and slower runoff than typical hill areas.

b. Derivation of local inflows for routing computations. The Big Black River drainage area was subdivided into subbasins as delineated by the Soil Conservation Service. Some minor modifications in indicated square mileage were made to subbasin drainage areas as furnished by the Soil Conservation Service in order to conform with established square mileage at the five key gaging stations. Local inflows for each subbasin were computed from synthetic unit hydrographs. Since observed gage and discharge data were very limited for small hill tributaries within the basin, curves were established to derive coefficients for unit hydrographs. These curves were based on data from other studies and are similar to curves used in the Cape Fear, North Carolina, basin study.

c. Rainfall and runoff. Average rainfall and runoff amounts were computed and used uniformly for all subbasins within each routing reach. Rainfall excess amounts were determined to approximate the runoff shown by discharge records at gaging stations, and correlated with reasonable infiltration indices. Infiltration rates used for the various areas in the basin vary from .01 to .06 inches per hour.

d. Tributary reservoir design. Seventeen locations were selected as potential sites for tributary reservoirs. Design of these reservoirs was based on criteria as outlined in EM 1110-2-1101, "Project Formulation and Design Criteria for Small Dams," dated 20 December 1957. Studies show that the reservoirs have about 10 inches of detention storage. Releases from the reservoirs were assumed to be 5 CFSM, with emptying period varying from 4 to 6 weeks. If these tributary reservoirs were in effect, the drainage area controlled would be about 33 percent or 940 square miles of the 2,810 square mile drainage area above Bovina, Mississippi. Summary of tributary reservoir sites is shown on Table A-3.

e. Soil Conservation Service reservoir design. The Soil Conservation Service has 21 flood detention structures currently in operation and propose an additional 203 for future construction. Detention storage in these reservoirs was based on a 50-year frequency storm rainfall and about 5 inches of runoff. The emptying period required is about 2 weeks if the reservoirs are filled to full pool. Releases vary from 5 CFSM at low pool to about 20 CFSM at full pool and average about 15 CFSM. There are 91 of the proposed 203 Soil Conservation Service structures not controlled by the Corps of Engineers tributary reservoirs located above Bovina, Mississippi. If all 91 structures were constructed, an additional 12 percent of the drainage area would be controlled. Summary of Corps of Engineers tributary and Soil Conservation Service reservoir sites is shown on Table A-3.

f. Routine procedures.

(1) The Big Black River Basin was divided into the following routine reaches:

(a) Above Kilmichael.

(b) Kilmichael - West.

(c) West - Pickens.

(d) Pickens - Bentonia.

(e) Bentonia - Bovina.

(2) The ends of reaches are at gaging stations where routed flow reproductions of observed discharges were made. Routings were

APPENDIX A

TABLE A-3
CE TRIBUTARY AND SCS
SUMMARY OF RESERVOIR SITES

Reach	Drainage Area Sq. Mi.	Tributary Reservoir Sites: Number of Sites	Tributary Reservoir Sites: D.A. Controlled Sq. Mi.	Uncontrolled Drainage Area Sq. Mi.	SCS [1] Reservoir Sites: Number of Sites	SCS [1] Reservoir Sites: Additional D.A. Contr. Sq. Mi.
Head to Kilmichael	549	4	177	293	17	82
Kilmichael - West	436	2	170	196	26	69
West - Pickens	475	3	180	234	23	61
Pickens - Bentonia	880	5	215	514	42	149
Bentonia - Bovina	470	3	200	269	4	15
Total above Bovina, Miss.	2,810	17	942	1,506	112 [2]	376

1/ SCS structures on tributaries not controlled by CE tributary reservoirs.

2/ Includes 21 SCS structures completed and in operation.

made by the Progressive Average-Lag method. Routing constants as determined by these check routing reproductions of the 1951 flood were used in determining the effects of the small reservoirs. Since it was impracticable to make detailed routings for long periods of record, variations amounting to 25, 50, 75, and 100 percent of the 1951 flood were routed to determine deductions for varying magnitude of flows. A typical comparative hydrograph of observed flows and variations of the 1951 flood is shown on Plate A-1. Data from these computations were used to construct curves of observed and modified peak flows at main stream gaging stations. The effects of various combinations of Corps of Engineer tributary and Soil Conservation Service reservoirs and channel improvement works were determined from these curves.

4. PLANS STUDIED

a. Main stem reservoir. A detail study was made for a main stem reservoir with purposes of flood control, hydroelectric power and recreation. A site was selected approximately 12.5 miles above Bovina, Mississippi, (referred to as the Edwards site) as having the best potential for development. The dam at the Edwards site would be of earthfill with crest elevation 201.0 feet, mean sea level, 75 feet above mean valley. The minimum pool at elevation 160.0 feet, mean sea level, has an area of 29,000 acres. Power pool storage amounts to 710,000 acre-feet and the flood control storage amounts to 1,000,000 acre-feet, equivalent to 7.0 inches of runoff. The reservoir would provide for a power installation of 28,000 kilowatts, with an average net head of 50 feet. Pertinent data are shown on Table A-9. A reservoir at this site would control about 80 percent of the basin's drainage, and would give the best reduction in peak stages at Bovina, Mississippi. Table A-8 shows the reductions in peak stages for the years 1940-1965.

b. Tributary reservoirs. Seventeen tributary reservoirs were studied varying in drainage area from 8 to 150 square miles. Pertinent data are shown on Table A-10. The total area controlled amounted to 940 square miles or about 35 percent of the area above Bovina, Mississippi. Reservoir inflows were routed through storage to obtain outflows. These were added to local flows from the uncontrolled areas and routed through river reaches using the "average lag" method. Controlled and uncontrolled areas are shown on Table A-3. The reductions in stages from tributary reservoirs for peak stages during 1940 through 1965 varied from less than 0.5 foot to 3.0 feet and average about one foot as shown on Table A-4 through A-8. The 112 Soil Conservation Service floodwater retarding structures on tributaries not controlled by the reservoirs produced additional stage reductions averaging about 0.5 foot from Kilmichael to Bentonia, and about one foot at Bovina.

c. Channel improvement.

(1) Channel enlargement or combinations of channel clearing, cleanout, and enlargement were used to provide sufficient improvements

to pass the design flows at design elevations for the several plans studied. Backwater computations were made to determine water surface profiles for improved conditions using Manning's formula, $Q = \frac{1.486}{n} ar^{2/3} s^{1/2}$, with "n" values ranging from .030 - .035 for channel enlargement, .040 for channel cleanout, .045 for channel clearing, and .050 - .060 for existing conditions. Channel improvement works required to contain flows within banks were determined for the following two alternates:

(a) Three-year frequency flow, May-October.

(b) One-year frequency flow, May-October.

(2) The design flowline and the flowline for design flows under existing conditions are shown on Plates 5 and 6 of the main report. These channel improvement requirements, together with various combinations of Corps of Engineer tributary and Soil Conservation Service reservoirs, were studied. The effects of channel improvement works on annual peaks for selected plans at the five key gaging stations are shown on Table A-4 through A-8. Some flooding will occur during the period of release from the Soil Conservation Service reservoirs but the duration will be short and occur generally after stages of greater magnitude. Stage hydrographs shown on Plate A-1 illustrate the effect of Soil Conservation Service reservoirs on variations of the 1951 flood at West, Mississippi. Channel improvement to contain SCS reservoir emptying flows within banks was found to be not economically justified.

d. Levees. Levee grades for the areas studied near Goodman and near the mouth of Apootka Creek were based on the 1951 flood of record confined with 3 feet freeboard.

5. FREQUENCIES

Frequency statistics. Frequency statistics were computed for all plans studied for each reach above Bovina, Mississippi, as outlined in "Statistical Methods in Hydrology," published under CWI Project CW-151 by the Sacramento District, Corps of Engineers. A typical array of frequency curves is shown at West, Mississippi, on Plate A-2.

APPENDIX A

TABLE A-4
EFFECTS OF PLANS STUDIED
AT
KILMICHAEL, MISSISSIPPI

Year	Month	Observed Peak Stage Feet	Tributary Reservoirs Only		SCS and Tributary Reservoirs		3-year Frequency Channel Only		3-year Frequency with SCS Reservoirs		1-year Frequency Channel Only		1-year Frequency with SCS Reservoirs	
			Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet
1940	Jul	15.2	14.5	0.7	14.3	0.9	13.4	1.8	13.0	2.2	14.3	0.9	13.9	1.3
1941	Nov	12.5	12.2	0.3	12.1	0.4	-1.9	14.4	-2.0	14.5	2.1	10.4	2.0	10.5
1942	Dec	13.2	12.9	0.3	12.8	0.4	1.8	11.4	1.7	11.5	5.6	7.6	5.5	7.7
1943	Mar	10.3	10.0	0.3	9.9	0.4	-7.6	17.9	-7.7	18.0	-3.3	13.6	-3.4	13.7
1944	May	15.1	14.4	0.7	14.1	1.0	13.2	1.9	12.7	2.4	14.2	0.9	13.7	1.4
1945	Mar	13.9	13.5	0.4	13.3	0.6	8.7	5.2	8.4	5.5	11.4	2.5	11.1	2.8
1946	Feb	15.2	14.8	0.4	14.6	0.6	13.4	1.8	13.2	2.0	14.3	0.9	14.1	1.1
1947	Apr	15.1	14.5	0.6	14.3	0.8	13.2	1.9	12.8	2.3	14.2	0.9	13.8	1.3
1948	Feb	14.2	13.8	0.4	13.6	0.6	10.1	4.1	9.8	4.4	12.3	1.9	12.0	2.2
1949	Jan	16.3	15.5	0.8	15.1	1.2	15.4	0.9	14.8	1.5	15.9	0.4	15.3	1.0
1950	Mar	15.3	14.6	0.7	14.2	0.9	13.7	1.6	13.2	2.1	14.5	0.8	14.0	1.3
1951	Mar	17.2	16.2	1.0	15.7	1.5	16.8	0.4	16.1	1.1	17.0	0.2	16.3	0.9
1952	Mar	12.6	12.2	0.4	12.1	0.5	-1.7	14.3	-1.9	14.5	2.5	10.1	2.3	10.3
1953	Feb	14.0	13.7	0.3	13.5	0.5	9.2	4.8	9.0	5.0	11.8	2.2	11.6	2.4
1954	May	13.7	13.4	0.3	13.3	0.4	7.3	6.4	7.2	6.5	10.6	3.1	10.5	3.2
1955	Apr	14.5	14.0	0.5	13.9	0.6	11.3	3.2	11.0	3.5	13.1	1.4	12.8	1.7
1956	Mar	13.7	13.4	0.3	13.3	0.4	7.3	6.4	7.2	6.5	10.6	3.1	10.5	3.2
1957	Nov	14.7	14.2	0.5	14.1	0.6	12.1	2.6	11.8	2.9	13.6	1.1	13.3	1.4
1958	Apr	14.3	13.9	0.4	13.7	0.6	10.6	3.7	10.4	3.9	12.6	1.7	12.4	1.9
1959	Apr	13.2	12.9	0.3	12.7	0.5	1.8	11.4	1.7	11.5	5.6	7.6	5.5	7.7

APPENDIX A

TABLE A-5
EFFECTS OF PLANS STUDIED
AT
WEST, MISSISSIPPI

Year	Month	Observed Peak Stage Feet	Tributary Reservoirs Only		SCS and Tributary Reservoirs		3-year Frequency Channel Only		3-year Frequency with SCS Reservoirs		1-year Frequency Channel Only		1-year Frequency with SCS Reservoirs	
			Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet
1940	Jul	21.2	20.0	1.2	19.6	1.6	18.0	3.2	16.8	4.4	19.9	1.3	18.7	2.5
1941	Nov	18.3	17.7	0.6	17.5	0.8	8.2	10.1	7.8	10.5	12.0	6.3	11.6	6.7
1942	Dec	18.9	18.2	0.7	18.0	0.9	10.9	8.0	10.5	8.4	14.7	4.2	14.3	4.6
1943	Mar	17.6	17.1	0.5	16.8	0.8	5.6	12.0	5.2	12.4	8.9	8.7	8.5	9.1
1944	Mar	22.4	21.0	1.4	20.5	1.9	19.9	2.5	19.0	3.4	21.5	0.9	20.6	1.8
1945	Mar	19.9	18.9	1.0	18.7	1.2	14.8	5.1	14.3	5.6	17.9	2.0	17.4	2.5
1946	Feb	22.6	21.1	1.5	20.5	2.1	20.2	2.4	19.2	3.4	21.8	0.8	20.8	1.8
1947	Apr	22.6	21.1	1.5	20.6	2.0	20.2	2.4	19.3	3.3	21.8	0.8	20.9	1.7
1948	Feb	22.3	20.9	1.4	20.3	2.0	19.8	2.5	18.9	3.4	21.4	0.9	20.5	1.8
1949	Jun	23.8	21.8	2.0	21.1	2.7	21.9	1.9	20.5	3.3	23.3	0.5	21.9	1.9
1950	Mar	21.4	20.2	1.2	19.8	1.6	18.3	3.1	17.6	3.8	20.2	1.2	19.5	1.9
1951	Mar	24.1	22.0	2.1	21.4	2.7	22.3	1.8	20.9	3.2	23.7	0.4	22.3	1.8
1952	Mar	17.6	17.1	0.5	18.8	0.8	5.6	12.0	5.2	12.4	8.9	8.7	8.5	9.1
1953	Feb	19.6	18.8	0.8	18.6	1.0	13.8	5.8	13.4	6.2	17.2	2.4	16.8	2.8
1954	May	20.6	19.5	1.1	19.1	1.5	16.7	3.9	16.1	4.5	19.0	1.6	18.4	2.2
1955	Apr	21.2	20.1	1.1	19.7	1.5	18.0	3.2	17.4	3.8	19.9	1.3	19.3	1.9
1956	Mar	19.8	18.9	0.9	18.6	1.2	14.5	5.3	14.0	5.8	17.7	2.1	17.2	2.6
1957	Nov	21.9	21.3	1.4	20.9	1.8	19.1	2.8	18.3	3.6	20.9	1.0	20.1	1.8
1958	Apr	21.1	20.0	1.1	19.6	1.5	17.8	3.3	17.2	3.9	19.7	1.4	19.1	2.0
1959	Dec	19.8	19.0	0.8	18.8	1.0	14.5	5.3	14.0	5.8	17.7	2.1	17.2	2.6
1960	Mar	20.0	19.1	0.9	18.8	1.2	15.1	4.9	14.6	5.4	18.0	2.0	17.5	2.5
1961	Dec	24.0	22.0	2.0	21.3	2.7	22.2	1.8	20.8	3.2	23.6	0.4	22.2	1.8
1962	Jan	20.3	19.3	1.0	19.0	1.3	15.9	4.4	15.4	4.9	18.5	1.8	18.0	2.3
1963	Jul	19.4	18.6	0.8	18.3	1.1	13.2	6.2	12.8	6.6	16.8	2.6	16.4	3.0
1964	Apr	20.0	19.1	0.9	18.8	1.2	15.1	4.9	14.6	5.4	18.0	2.0	17.5	2.5
1965	Feb	22.5	21.0	1.5	20.4	2.1	20.1	2.4	19.1	3.4	21.7	0.8	20.7	1.8

APPENDIX A

TABLE A-6
EFFECTS OF PLANS STUDIED
AT
PICKENS, MISSISSIPPI

Year	Month	Observed Peak Stage Feet	Tributary Reservoirs Only		SCS and Tributary Reservoirs		3-year Frequency Channel Only		3-year Frequency with SCS Reservoirs		1-year Frequency Channel Only		1-year Frequency with SCS Reservoirs	
			Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet
1940	Jul	28.2 (1)	27.5	0.7	27.2	1.0	25.3	2.9	24.6	3.6	27.2	1.0	26.5	1.7
1941	Jul	26.8 (1)	26.0	0.8	26.0	0.8	20.8	6.0	20.8	6.0	25.1	1.7	25.1	1.7
1942	Dec	27.2 (1)	26.7	0.5	26.5	0.7	22.4	4.8	22.1	5.1	25.8	1.4	25.5	1.7
1943	Dec	26.9 (1)	26.3	0.6	26.2	0.7	21.3	5.6	21.2	5.7	25.3	1.6	25.2	1.7
1944	Mar	30.2 (2)	29.1	1.1	28.5	1.7	28.6	1.6	28.5	1.7	29.6	0.6	29.5	0.7
1945	Feb	27.6 (1)	27.0	0.6	26.8	0.8	23.7	3.9	23.1	4.5	26.4	1.2	25.8	1.8
1946	Feb	30.1 (2)	29.1	1.0	28.6	1.5	28.5	1.6	27.5	2.6	29.5	0.6	28.5	1.6
1947	Apr	28.1 (2)	27.4	0.7	27.2	0.9	25.1	3.0	24.4	3.7	27.1	1.0	26.4	1.7
1948	Feb	28.4	27.5	0.9	27.1	1.3	25.7	2.7	24.8	3.6	27.5	0.9	26.6	1.8
1949	Jan	29.4	28.4	1.0	27.8	1.6	27.6	1.8	26.6	2.8	28.7	0.7	27.7	1.7
1950	Feb	27.5	26.7	0.6	26.4	0.9	23.4	4.1	22.8	4.7	26.3	1.2	25.7	1.8
1951	Mar	31.6	30.0	1.6	29.7	1.9	30.2	1.4	28.6	3.0	31.2	0.4	29.6	2.0
1952	Jan	24.6	23.8	0.8	23.8	0.8	10.7	13.9	10.7	13.9	15.8	8.8	15.8	8.8
1953	May	27.1	26.6	0.5	26.4	0.7	22.1	5.0	21.6	5.5	25.7	1.4	25.2	1.9
1954	May	26.7	26.2	0.5	26.0	0.7	20.5	6.2	20.1	6.6	24.9	1.8	24.5	2.2
1955	Apr	27.7	27.1	0.6	26.8	0.9	24.0	3.7	23.4	4.3	26.5	1.2	25.9	1.8
1956	Apr	27.8	27.2	0.6	27.0	0.8	24.3	3.5	23.7	4.1	26.7	1.1	26.1	1.7
1957	Feb	26.7	25.9	0.8	25.6	1.1	20.5	6.2	19.7	7.0	24.9	1.8	24.1	2.6
1958	May	30.8	29.6	1.2	29.4	1.8	29.3	1.5	28.1	2.7	30.3	0.5	29.1	1.7
1959	Apr	25.6	25.1	0.5	24.9	0.7	14.6	11.0	14.4	11.2	19.4	6.2	19.2	6.4
1960	Mar	27.1	26.5	0.6	26.3	0.8	22.1	5.0	21.5	5.6	25.7	1.4	25.1	2.0
1961	Dec	31.4	30.1	1.3	29.5	1.9	30.0	1.4	28.7	2.7	31.0	0.4	29.7	1.7
1962	Apr	27.7	27.0	0.7	26.8	0.9	24.0	3.7	23.3	4.4	26.5	1.2	25.8	1.9
1963	Mar	18.9	18.6	0.3	18.6	0.3	2.6	16.3	2.6	16.3	7.2	11.7	7.2	11.7
1964	Mar	26.9	26.4	0.5	26.2	0.7	21.3	5.6	20.8	6.1	25.3	1.6	24.8	2.1
1965	Feb	28.1	27.4	0.7	27.0	1.1	25.1	3.0	24.4	3.7	27.1	1.0	26.4	1.7

(1) Estimated by stage relation.

(2) HWM

APPENDIX A

TABLE A-7
EFFECTS OF PLANS STUDIED
AT
BENTONIA, MISSISSIPPI

Year	Month	Observed Peak Stage Feet	Tributary Reservoirs Only		SCS and Tributary Reservoirs		3-year Frequency Channel Only		3-year Frequency with SCS Reservoirs		1-year Frequency Channel Only		1-year Frequency with SCS Reservoirs	
			Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet	Stage Feet	Reduction Feet
1940	July	19.9	19.2	0.7	18.9	1.0	17.4	2.5	17.0	2.9	18.9	1.0	18.5	1.4
1941	Mar	17.1	16.7	0.4	16.4	0.7	4.2	12.9	3.8	13.3	8.9	8.2	8.5	8.6
1942	Jan	17.4	17.0	0.4	16.7	0.7	5.2	12.2	4.8	12.6	10.0	7.4	9.6	7.8
1943	Jan	18.4	17.4	1.0	17.0	1.4	10.6	7.8	10.0	8.4	15.4	3.0	14.8	3.6
1944	Mar	20.3	19.3	1.0	19.0	1.3	18.1	2.2	17.5	2.8	19.4	0.9	18.8	1.5
1945	Feb	19.2	18.7	0.5	18.4	0.8	15.2	4.0	14.9	4.3	17.8	1.4	17.5	1.7
1946	Feb	20.8	19.8	1.0	19.4	1.4	18.9	1.9	18.2	2.6	20.1	0.7	19.4	1.4
1947	Apr	20.2	19.5	0.7	19.2	1.0	18.0	2.2	17.5	2.7	19.3	0.9	18.8	1.4
1948	Feb	20.5	19.5	1.0	19.2	1.3	18.4	2.1	17.8	2.7	19.7	0.8	19.1	1.4
1949	Jan	22.0	20.9	1.1	20.5	1.5	20.6	1.4	19.8	2.2	21.6	0.4	20.8	1.2
1950	Mar	19.4	18.3	0.6	18.6	0.8	16.2	3.2	15.9	3.5	18.1	1.3	17.8	1.6
1951	Mar	22.2	20.8	1.4	20.2	2.0	20.8	1.4	19.6	2.6	21.9	0.3	20.7	1.5
1952	Dec	18.5	17.9	0.6	17.5	1.0	11.3	7.2	10.7	7.8	16.1	2.4	15.5	3.0
1953	Feb	18.6	18.1	0.5	17.8	0.8	11.8	6.8	11.5	7.1	16.5	2.1	16.2	2.4
1954	May	18.8	18.3	0.5	18.0	0.8	13.0	5.8	12.7	6.1	17.1	1.7	16.8	2.0
1955	Apr	18.8	18.3	0.5	18.0	0.8	13.0	5.8	12.7	6.1	17.1	1.7	16.8	2.0
1956	Mar	18.5	17.9	0.6	17.5	1.0	11.3	7.2	11.0	7.5	16.1	2.4	15.8	2.7
1957	Nov	19.6	18.9	0.7	18.6	1.0	16.8	2.8	16.4	3.2	18.4	1.2	18.0	1.6
1958	May	20.2	19.4	0.8	19.2	1.0	18.0	2.2	17.5	2.7	19.3	0.9	18.8	1.4
1959	Feb	18.2	17.5	0.7	17.1	1.1	9.5	8.7	9.2	9.0	14.1	4.1	13.8	4.4
1960	Mar	18.4	17.9	0.5	17.6	0.8	10.6	7.8	10.3	8.1	15.4	3.0	15.1	3.3
1961	Dec	21.5	20.4	1.1	20.0	1.5	19.9	1.6	19.1	2.4	21.0	0.5	20.2	1.3
1962	Jan	18.8	18.3	0.5	18.0	0.8	13.0	5.8	12.7	6.1	17.1	1.7	16.8	2.0
1963	Jul	14.6	14.0	0.3	13.8	0.5	-1.3	15.9	-1.6	16.2	3.5	11.1	3.2	11.4
1964	Mar	18.5	17.9	0.6	17.5	1.0	11.3	7.2	11.0	7.5	16.1	2.4	15.8	2.7
1965	Feb	20.4	19.5	0.9	19.2	1.2	18.3	2.1	17.7	2.7	19.6	0.8	19.0	1.4

APPENDIX A

TABLE A-8
EFFECTS OF PLANS STUDIED
AT
BOVINA, MISSISSIPPI

Year	Month	Observed Peak Stage Feet	Modified Stages: Tributary Reservoirs Only: Stage Feet	Tributary Reservoirs Only: Reduction Feet	SCS and Tributary Reservoirs: Stage Feet	SCS and Tributary Reservoirs: Reduction Feet	3-year Frequency Channel Only: Stage Feet	3-year Frequency Channel Only: Reduction Feet	3-year Frequency with SCS Reservoirs: Stage Feet	3-year Frequency with SCS Reservoirs: Reduction Feet	1-year Frequency Channel Only: Stage Feet	1-year Frequency Channel Only: Reduction Feet	1-year Frequency with SCS Reservoirs: Stage Feet	1-year Frequency with SCS Reservoirs: Reduction Feet	Main Stem Reservoir: Stage Feet	Main Stem Reservoir: Reduction Feet
1940	Jul	38.3	37.1	1.2	36.3	2.0	31.1	7.2	30.1	8.2	36.5	1.8	35.5	2.8	34.5	3.8
1941	Jan	33.8	31.5	2.3	30.5	3.3	22.6	11.2	21.2	12.6	27.8	6.0	26.4	7.4	25.4	8.4
1942	Mar	30.4	27.4	3.0	26.5	3.9	19.0	11.4	17.4	13.0	24.0	6.4	22.4	8.0	21.2	9.2
1943	Jan	32.8	30.4	2.4	29.3	3.5	21.6	11.2	20.3	12.5	26.7	6.1	25.4	7.4	23.8	9.0
1944	Apr	39.0	38.3	0.7	38.1	0.9	34.4	4.6	34.0	5.0	38.2	0.8	37.8	1.2	37.0	2.0
1945	Feb	36.5	34.6	1.9	33.6	2.9	26.2	10.3	24.7	11.8	31.4	5.1	29.9	6.6	30.2	6.3
1946	Feb	39.1	38.4	0.7	38.2	0.9	34.9	4.2	34.5	4.6	38.3	0.8	37.9	1.2	1/	-
1947	Jan	38.0	36.8	1.2	26.1	1.9	29.9	8.1	29.0	9.0	35.4	2.6	34.5	3.5	33.6	4.4
1948	Feb	38.3	37.4	0.9	36.9	1.4	31.1	7.2	30.4	7.9	36.5	1.8	35.8	2.5	34.5	3.8
1949	Jan	39.2	38.5	0.7	38.3	0.9	35.6	3.6	35.2	4.0	38.5	0.7	38.1	1.1	37.4	1.8
1950	Feb	37.2	36.0	1.2	35.2	2.0	27.6	9.6	26.6	10.6	32.8	4.4	31.8	5.4	31.6	5.6
1951	Apr	39.7	39.2	0.5	39.0	0.7	37.4	2.3	37.0	2.7	39.2	0.5	38.8	.9	38.4	1.3
1952	Jan	23.6	20.0	3.6	17.0	6.6	13.5	10.1	11.9	11.7	18.1	5.5	16.5	7.1	17.6	6.0
1953	May	37.1	35.7	1.4	34.9	2.2	27.4	9.7	26.3	10.8	32.5	4.6	31.4	5.7	31.4	5.7
1954	May	32.7	30.4	2.3	29.5	3.2	21.4	11.3	20.0	12.7	26.6	6.1	25.2	7.5	23.7	9.0
1955	Apr	36.8	35.3	1.5	34.4	2.4	26.8	10.0	25.6	11.2	31.9	4.9	30.7	6.1	30.8	6.0
1956	Apr	37.3	36.0	1.3	35.2	2.1	27.9	9.4	26.9	10.4	32.9	4.4	31.9	5.4	31.8	5.5
1957	Nov	38.4	37.2	1.2	36.5	1.9	31.4	7.0	30.5	7.9	36.7	1.7	35.8	2.6	34.9	3.5
1958	May	39.7	39.1	0.6	38.9	0.8	37.4	2.3	37.0	2.7	39.2	0.5	38.8	.9	38.4	1.3
1959	Feb	29.1	25.6	3.5	24.8	4.3	17.6	11.5	15.8	13.3	22.7	6.4	20.9	8.2	20.4	8.7
1960	Mar	36.3	34.4	1.9	33.4	2.9	25.9	10.4	24.5	11.8	31.1	5.2	29.7	6.6	29.8	6.5
1961	Dec	40.5	40.1	0.4	39.9	0.6	39.0	1.5	38.7	1.8	40.1	0.4	39.8	.7	39.4	1.1
1962	Apr	38.1	36.7	1.4	35.8	2.2	30.2	7.9	29.1	9.0	35.8	2.3	34.7	3.4	33.8	4.3
1963	Jul	18.2	15.5	2.7	14.5	3.7	10.5	7.7	8.8	9.4	14.4	3.8	12.7	5.5	16.3	1.9
1964	Mar	35.9	33.9	2.0	33.0	2.9	25.3	10.6	23.8	12.1	30.5	5.4	29.0	6.9	29.1	6.8
1965	Feb	38.3	37.2	1.1	36.6	1.7	31.1	7.2	30.3	8.0	36.5	1.8	35.7	2.6	34.5	3.8

1/ No Reduction - Spillway in Operation

APPENDIX A

TABLE A-9
PERTINENT DATA
EDWARDS RESERVOIR

Item	Unit	Multi-Purpose F. C., Power and Rec.	Alternative Projects	
			F. C. and Rec.	Power and Rec.
DRAINAGE AREA	sq. mi.	2,654	2,654	2,654
MINIMUM POOL				
Elevation	ft. msl	160.0	165.0	160.0
Area	acres	29,000	36,000	29,000
Storage	ac. ft.	410,000	570,000	410,000
	Inches	2.9	4.0	2.9
POWER POOL				
Elevation	ft. msl	177.0	-	177.0
Area	acres	56,000	-	56,000
Storage	ac. ft.	710,000	-	710,000
	Inches	5.0	-	5.0
FLOOD CONTROL POOL				
Elevation	ft. msl	191.0	184.0	-
Area	acres	88,000	70,000	-
Storage	ac. ft.	1,000,000	990,000	-
	Inches	7.1	7.0	-
SURCHARGE POOL				
Elevation	ft. msl	195.3	188.2	186.2
Area	acres	101,000	81,000	76,000
Storage	ac. ft.	440,000	320,000	600,000
	Inches	3.5	2.3	4.2
DAM - Earthfill				
Crest Elevation	ft. msl	201.0	194.0	192.0
Freeboard	ft.	5.7	5.8	5.8
SPILLWAY - Conc. Gravity				
Crest Elevation	ft. msl	151.0	151.0	151.0
Crest length, net	ft.	250	350	350
Gates, Tainter, No.	No.	5	7	7
Size, W X H	ft.	50 X 31	50 X 35	50 X 28
Peak Discharge	cfs			
POWER				
Installation	kw	28,000	-	28,000
Dependable Capacity	kw	20,000	-	20,000
Average Annual Energy	kw	96,000,000	-	96,000,000

PERTINENT DA

Item	Unit	Calabrella Creek	McCurtain Creek	Wolf Creek	Mulberry Creek	Poplar Creek
DRAINAGE AREA	sq mi	45.2	38.6	44.6	44.7	81.2
ONE-INCH RUNOFF	acre-ft	2,411	2,059	2,379	2,384	4,331
CONSERVATION POOL						
Elevation	ft msl	359.0	357.0	339.0	332.0	334.0
Area	acres	620	520	510	790	1,200
Storage	acre-ft	3,900	3,100	3,100	4,000	6,800
Equivalent runoff	inches	1.6	1.5	1.3	1.7	1.6
FLOOD CONTROL POOL						
Elevation	ft msl	377.0	374.0	356.0	348.0	3,500
Area	acres	2,000	2,000	2,200	2,100	3,600
Storage	acre-ft	23,100	19,800	22,700	23,000	40,400
Equivalent runoff	inches	9.6	9.6	9.5	9.6	9.3
Release rate-average	cfsm	5	5	5	5	5
SURCHARGE POOL						
Standard project flood						
Elevation	ft msl	383.7	380.2	362.2	354.6	356.6
Area	acres	2,700	2,700	2,900	2,800	4,800
Storage	acre-ft	15,300	15,200	17,000	16,000	27,800
Equivalent runoff	inches	6.3	7.3	7.1	6.7	6.4
100-year frequency flood						
Elevation	ft msl	380.8	377.6	359.7	351.9	353.9
Area	acres	2,400	2,400	2,600	2,500	4,300
Storage	acre-ft	8,000	7,700	9,000	9,000	15,800
Equivalent runoff	inches	3.3	3.7	3.8	3.8	3.6
DAM						
Crest elevation	ft msl	387.0	384.0	366.0	358.0	360.0
Freeboard						
Standard project flood	ft	3.3	3.8	3.8	3.4	3.4
100-year frequency flood	ft	6.2	6.4	6.3	6.1	6.1
OUTLET WORKS						
Number of conduits		1	1	1	1	1
Size						
Diameter	inches	48	42	48	48	60
Inlet invert elevation	ft msl	350.0	346.0	326.0	322.0	322.0
Outlet invert elevation	ft msl	348.0	344.0	324.0	320.0	320.0
Intake structure						
Sluice gate - size	inches	24	24	24	24	30
Riser - size	ft	7X7	6X7	7X7	7X7	8.5X8.5
Capacity at top FC pool	cfs	280	210	300	280	470
SPILLWAY						
Type		Veg.	Veg.	Veg.	Veg.	Veg.
Crest elevation	ft msl	377.0	374.0	356.0	348.0	350.0
Crest length	ft	500	400	400	400	600
Peak discharge						
Standard project flood	cfs	27,000	19,000	19,000	21,000	31,000
100-year frequency flood	cfs	11,000	8,500	8,800	9,500	14,000

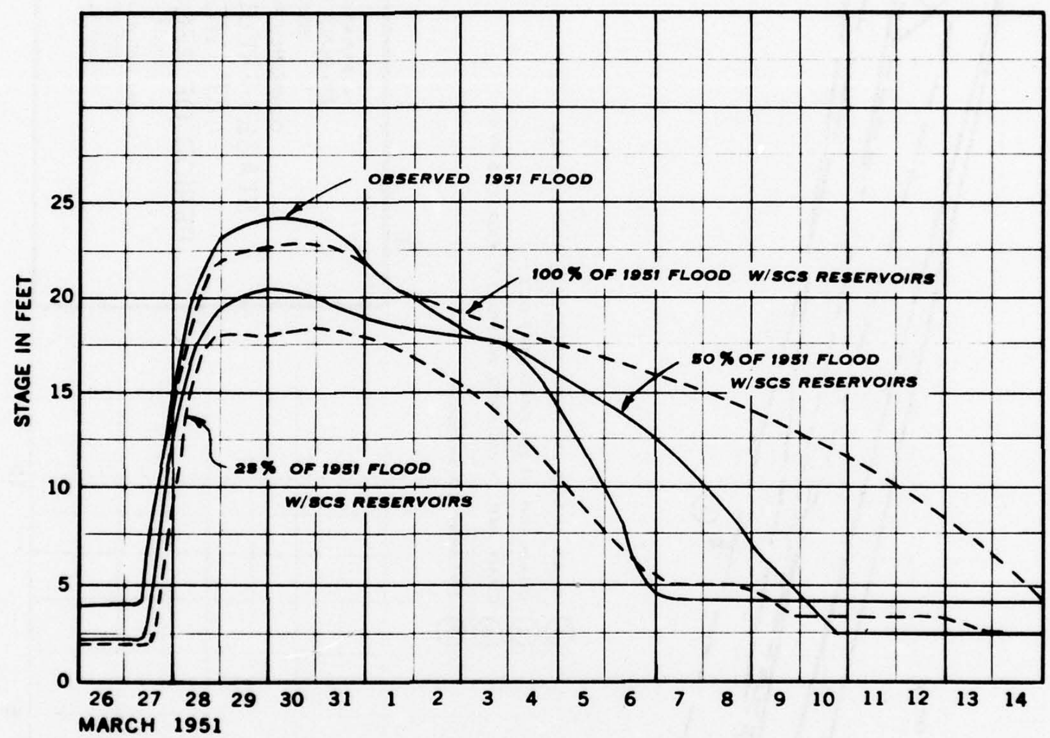
APPENDIX A
TABLE A-10
PERTINENT DATA, CE TRIBUTARY RESERVOIRS

McCurtain Creek	Wolf Creek	Mulberry Creek	Poplar Creek	Zilpha Creek	Sharkey Creek	Apookta Creek	Seneatcha Creek	Big Cypress Creek	Vaughan Creek	Hobuck Creek
38.6	44.6	44.7	81.2	89.0	20.6	59.0	99.7	78.8	8.1	8.0
2,059	2,379	2,384	4,331	4,747	1,099	3,147	5,817	4,203	432	427
357.0	339.0	332.0	334.0	310.0	304.0	291.0	248.0	233.0	235.0	272.0
520	510	790	1,200	1,100	370	810	1,400	1,200	150	130
3,100	3,100	4,000	6,800	8,000	2,000	5,800	8,000	5,500	750	600
1.5	1.3	1.7	1.6	1.7	1.8	1.8	1.5	1.3	1.7	1.4
374.0	356.0	348.0	3,500	328.0	319.0	310.0	264.0	248.0	247.0	285.0
2,000	2,200	2,100	3,600	3,900	1,300	2,600	4,300	4,200	540	560
19,800	22,700	23,000	40,400	43,500	10,600	29,700	47,000	38,500	4,200	4,200
9.6	9.5	9.6	9.3	9.2	9.6	9.4	8.8	9.2	9.8	9.8
5	5	5	5	5	5	5	5	5	5	5
380.2	362.2	354.6	356.6	334.3	324.9	316.4	270.1	253.8	252.5	290.1
2,700	2,900	2,800	4,800	4,900	1,700	3,400	5,700	5,800	830	840
15,200	17,000	16,000	27,800	28,500	9,700	19,500	33,000	28,000	3,700	3,800
7.3	7.1	6.7	6.4	6.0	8.8	6.2	6.2	6.7	8.6	8.9
377.6	359.7	351.9	353.9	331.8	322.4	313.8	267.8	251.7	250.1	287.9
2,400	2,600	2,500	4,300	4,400	1,500	3,100	5,200	5,200	700	720
7,700	9,000	9,000	15,800	16,500	5,400	10,500	19,000	17,000	1,700	1,800
3.7	3.8	3.8	3.6	3.5	4.9	3.3	3.6	4.0	3.9	4.2
384.0	366.0	358.0	360.0	338.0	328.0	320.0	274.0	257.0	256.0	294.0
3.8	3.8	3.4	3.4	3.7	3.1	3.6	3.9	3.2	3.5	3.9
6.4	6.3	6.1	6.1	6.2	5.6	6.2	6.2	5.3	5.9	6.1
1	1	1	1	1	1	1	1	1	1	1
42	48	48	60	60	36	48	66	60	24	24
346.0	326.0	322.0	322.0	293.0	292.0	272.0	232.0	220.0	221.0	264.0
344.0	324.0	320.0	320.0	291.0	290.0	270.0	230.0	218.0	219.0	262.0
24	24	24	30	30	18	24	36	30	12	12
6X7	7X7	7X7	8.5X8.5	8.5X8.5	5.5X5.5	7X7	9X9	8.5X8.5	4X4	4X4
210	300	280	470	520	150	330	620	470	60	50
Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
374.0	356.0	348.0	350.0	328.0	319.0	310.0	264.0	248.0	247.0	285.0
400	400	400	600	700	150	600	700	500	100	100
19,000	19,000	21,000	31,000	34,000	6,600	30,000	33,000	22,000	4,000	3,600
8,500	8,800	9,500	14,000	16,000	2,900	14,000	16,000	11,000	1,700	1,500

2

Seneatcha Creek	Big Cypress Creek	Vaughan Creek	Hobuck Creek	Doaks Creek	Panther Creek	Bogue Chitto	Porters --Cox	Bear Creek
99.7	78.8	8.1	8.0	103.2	17.4	151.0	35.3	14.3
5,817	4,203	432	427	5,504	928	8,053	1,883	763
248.0	233.0	235.0	272.0	238.0	219.0	179.0	158.0	205.0
1,400	1,200	150	130	1,900	450	2,000	500	160
8,000	5,500	750	600	10,000	1,300	12,100	2,800	1,000
1.5	1.3	1.7	1.4	1.8	1.4	1.5	1.5	1.3
264.0	248.0	247.0	285.0	253.0	230.0	196.0	174.0	228.0
4,300	4,200	540	560	5,200	1,200	6,900	1,700	560
47,000	38,500	4,200	4,200	50,000	9,000	69,900	17,700	7,500
8.8	9.2	9.8	9.8	9.1	9.7	8.7	9.4	9.8
5	5	5	5	5	5	5	5	5
270.1	253.8	252.5	290.1	259.1	235.7	201.8	180.4	235.2
5,700	5,800	830	840	7,200	1,800	9,100	2,400	800
33,000	28,000	3,700	3,800	38,000	8,400	48,000	12,400	5,000
6.2	6.7	8.6	8.9	6.9	9.1	6.0	6.6	6.6
267.8	251.7	250.1	287.9	256.8	233.3	199.8	177.6	231.9
5,200	5,200	700	720	6,400	1,500	8,300	2,100	680
19,000	17,000	1,700	1,800	23,000	4,500	29,000	6,500	2,500
3.6	4.0	3.9	4.2	4.2	4.8	3.6	3.5	3.3
274.0	257.0	256.0	294.0	263.0	239.0	205.0	184.0	239.0
3.9	3.2	3.5	3.9	3.9	3.3	3.2	3.6	3.3
6.2	5.3	5.9	6.1	6.2	5.7	5.2	6.4	7.1
1	1	1	1	1	1	1	1	1
66	60	24	24	66	36	78	42	30
232.0	220.0	221.0	264.0	220.0	209.0	162.0	142.0	192.0
230.0	218.0	219.0	262.0	218.0	207.0	160.0	140.0	190.0
36	30	12	12	36	18	42	24	18
9X9	8.5X8.5	4X4	4X4	9X9	5.5X5.5	11X11	6X7	5X5
620	470	60	50	630	130	910	220	100
Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
264.0	248.0	247.0	285.0	253.0	230.0	196.0	174.0	228.0
700	500	100	100	600	150	1,000	400	200
33,000	22,000	4,000	3,600	28,000	6,300	43,000	20,000	12,000
16,000	11,000	1,700	1,500	14,000	2,900	23,000	8,400	4,800

3



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

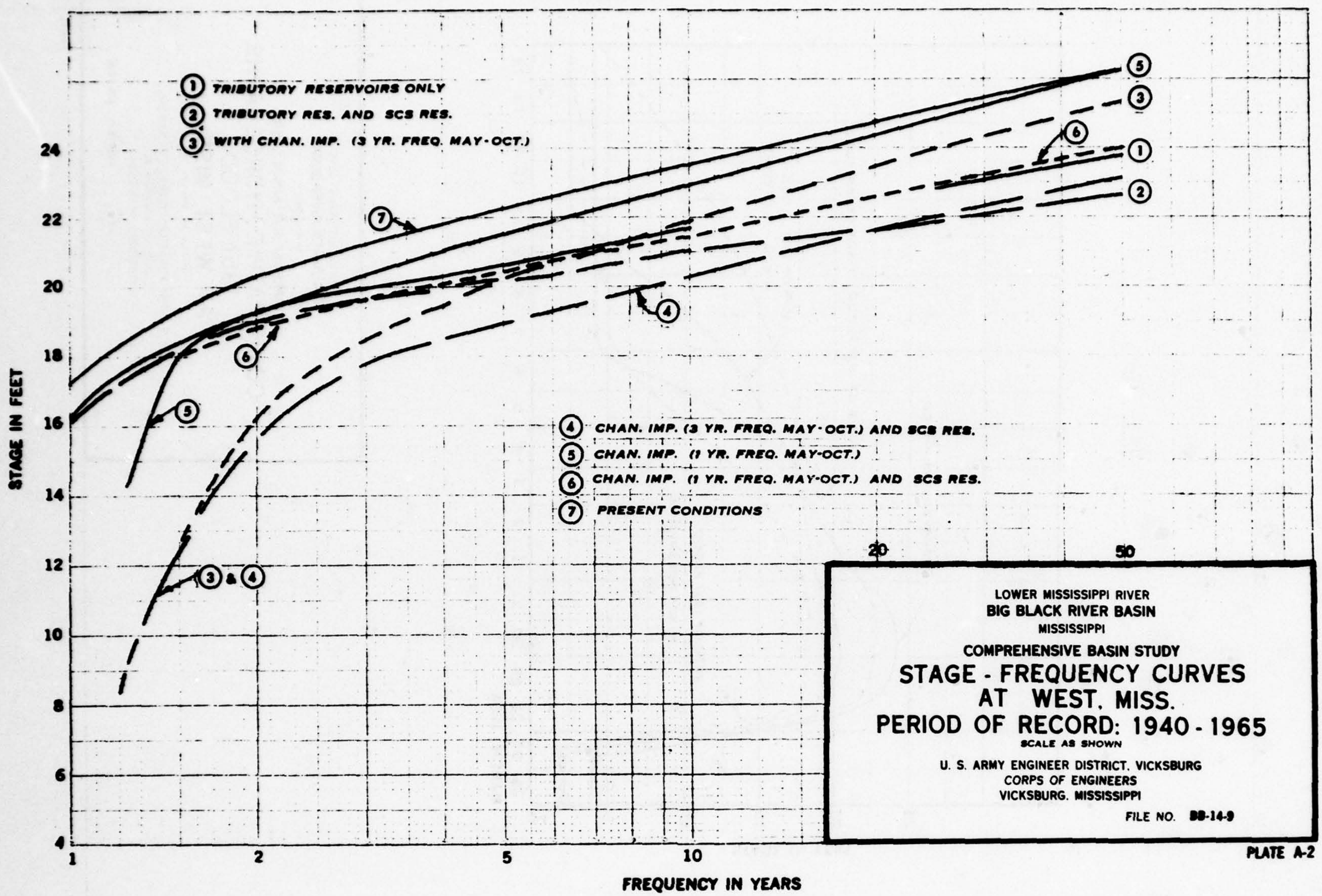
COMPARATIVE HYDROGRAPHS 1951 FLOOD AT WEST, MISS.

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO BB-14-9

PLATE A-1



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI

COMPREHENSIVE BASIN STUDY

STAGE - FREQUENCY CURVES AT WEST, MISS.
PERIOD OF RECORD: 1940 - 1965

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

PLATE A-2

APPENDIX B
BIG BLACK RIVER BASIN
ECONOMIC BASE SUMMARY

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TABLES

TABLES (Continued)

APPENDIX B

BIG BLACK RIVER BASIN
ECONOMIC BASE SUMMARY

1. INTRODUCTION

This presentation is a summary of the data included in an Economic Base Study prepared by Michael Baker, Jr., Inc., Jackson, Mississippi, and studies made by the U. S. Department of Agriculture. Two areas are summarized: the study area and the flood plain of the Big Black River. Information presented for the flood plain will be limited to its agricultural resource.

2. THE STUDY AREA

a. Delineation of the study area. The study area encompasses a total of 4,467,100 acres in the State of Mississippi. This area includes the counties of Attala, Carroll, Choctaw, Claiborne, Hinds, Holmes, Madison, Montgomery, Warren, Webster, and Yazoo. All data presented in this paragraph except for land usage does not include the eastern portion of Hinds County, which includes Jackson, Mississippi. The Big Black River Basin drainage area includes only portions of these counties amounting to approximately 2,112,000 acres. All data included in paragraph 2 is presented for the study area. Agricultural uses of land in the study area account for 4,238,400 acres as compared to 228,700 acres devoted to other uses with less than one percent of the total area being surface water. Of that land devoted to agricultural uses, approximately 58 percent is forest land, 22 percent cropland, 15 percent pasture land, and 5 percent other land.

b. General economic growth.

(1) Population and population projections. The population of the study area after 1940 realized a decline through 1965; however, the projected population is expected to be 248,000 in 1980 and reach 379,000 in 2015. The urban proportion of this population is forecast to realize a substantial increase, and the rural nonfarm portion some increase. The rural farm population is expected to decrease to 31,000 in 1980 and 23,000 in 2015. The reversal of an overall population decline is expected to occur due to the growth of Vicksburg and the area surrounding Jackson. Population of the study area for the period 1930 to 2015 is shown in the table below.

TABLE B-1
POPULATION OF THE STUDY AREA
(in thousands)

Item	1930	1940	1950	1960	Estimate: 1965	Projected: 1980	Projected: 2015
Urban	41.7	52.7	61.0	73.0	78.1	100.0	219.4
Rural							
Farm	195.9	202.2	145.3	71.4	52.0	30.7	23.0
Nonfarm	36.4	43.9	60.0	97.5	105.3	117.8	136.6
Total	274.0	298.8	266.3	241.9	235.4	248.5	379.0

Source: Economic Base Study of the Pascagoula, Pearl and Big Black River Basins Study Area, Volumes I and II, Michael Baker, Jr., Inc.

(2) Labor force. The labor force of the study area decreased by 33 percent from 1930 to 1960. It is expected to reach a low point and then return to the 1960 level by 1980. The labor force is projected to continue on an upward trend to the year 2015. Table B-2 shows the labor force in the study area for the period 1930 to 2015.

TABLE B-2
THE LABOR FORCE OF THE STUDY AREA

Year	Labor force	Participation rate 1/ (percent)
1930	119,200	66.8
1940	114,000	56.7
1950	94,000	53.8
1960	80,300	52.0
1965 (estimated)	77,300	51.0
1980 (projected)	81,900	52.2
2015 (projected)	124,900	53.1

1/ Percentage of population 14 years old and over in the labor force.

Source: Economic Base Study of the Pascagoula, Pearl and Big Black River Basins Study Area, Volumes I and II, Michael Baker, Jr., Inc.

(3) Employment.

(a) Agricultural employment, which includes those persons employed in agriculture, forestry and fisheries, has declined steadily in the study area. In 1930, almost three-fourths of the jobs were agricultural, by 1960 this ratio dropped to one-fourth, and is expected to fall to slightly over one-twentieth by 2015. Agricultural employment in the study area is shown in Table B-3.

TABLE B-3
EMPLOYMENT BY MAJOR CATEGORIES IN THE STUDY AREA

Year	Agricultural	Manufacturing	Nonagricultural nonmanufacturing	Total
1930	83,014	4,303	27,610	114,927
1940	63,193	5,836	30,990	100,019
1950	41,806	7,596	40,350	89,752
1960	20,146	10,714	43,304	74,164
1965 (est)	14,600	11,670	43,900	70,200
1980 (proj)	8,500	15,010	48,600	72,100
2015 (proj)	6,000	31,440	71,800	109,200

Source: Economic Base Study of the Pascagoula, Pearl and Big Black River Basins Study Area, Volumes I and II, Michael Baker, Jr., Inc.

(b) Employment in manufacturing includes those persons involved with the mechanical or chemical transformation or organic and inorganic substances into new products. A slight increase in manufacturing employment occurred during the period 1930 to 1960. This trend is expected to continue and will reach an alltime high by 2015. The manufacturing category of Table B-3 includes major water-using manufacturing industries. A further breakdown of employment in manufacturing is indicated in Table B-4.

(c) The nonagricultural, nonmanufacturing category includes those persons employed in mining, construction, transportation and communications, utilities, wholesale and retail trade, finance, insurance and real estate services, government and all other industries not included in the manufacturing category. This category has dominated the employment categories since 1960 and will continue its domination, reaching an alltime high by 2015. Table B-5 presents a breakdown of the nonagricultural, nonmanufacturing category.

TABLE B-4
STUDY AREA EMPLOYMENT IN MANUFACTURING INDUSTRIES

Major Groups	1930	1940	1950	1960	1965	1980	2015
Textiles	124	279	382	145	130	180	240
Apparel	30	29	258	1,673	1,740	2,670	6,870
Lumber, Wood, & Furniture	3,459	4,645	5,274	4,283	3,960	2,700	3,250
Printing and Publishing	67	173	183	288	280	330	670
Stone, Clay, & Glass	-	9	28	150	220	320	880
Fab. Metals	-	9	45	271	310	440	990
Machinery (except electrical)	-	20	195	513	730	1,370	3,490
Electrical machinery	-	-	3	560	780	1,430	3,580
Transportation equip.	-	14	186	650	670	1,140	2,950
Others 1/	244	58	98	334	640	960	1,490
Major water-using 2/	379	600	944	1,847	2,210	3,470	7,030
Total	4,303	5,836	7,596	10,714	11,670	15,010	31,440

1/ Includes tobacco manufacturers, rubber and plastic products, leather and leather products, instruments and related products, ordnance and accessories and miscellaneous manufacturing industries except in 1930, when adequate data were not available to determine classifications.

2/ Includes food, pulp and paper, chemical, petroleum and primary metal industries. Food and chemical industries have dominated this major group in the past and will continue this domination in the future.

Source: Economic Base Study of the Pascagoula, Pearl and Big Black River Basins Study Area, Volumes I and II, Michael Baker, Jr., Inc.

TABLE B-5
STUDY AREA EMPLOYMENT IN NONAGRICULTURAL-NONMANUFACTURING

Major Groups	1930	1940	1950	1960	Estimated 1965	Projected 1980	Projected 2015
Mining	81	573	573	434	480	490	540
Construction	1,445	3,591	4,485	4,542	4,590	5,060	7,880
Transportation and communication	3,864	2,393	2,944	2,831	2,840	2,900	3,140
Utilities	902	462	701	919	950	1,050	1,280
Wholesale and retail trade	6,592	7,564	11,189	10,992	11,180	12,610	19,410
Finance, insurance and real estate	757	809	1,185	1,761	1,770	1,830	3,240
Services	10,220	10,697	9,226	10,914	11,050	12,460	18,500
Government	2,698	3,967	8,628	9,336	9,510	10,650	16,000
Other	1,051	934	1,558	1,529	1,530	1,550	1,810
Total	27,610	30,900	40,350	43,304	43,900	48,600	71,800

Source: Economic Base Study of the Pascagoula, Pearl and Big Black River Basins Study Area, Volume I and II, Michael Baker, Jr., Inc.

(4) Income - past, present and future.

(a) Per capita income in the study area is considerably below the national average. In 1960, per capita income was $1,139, and the national average was $2,271. Although the projected per capita income is expected to increase substantially by 2015 in the study area, the difference between it and the national average is expected to exist for many years. Total personal and per capita income in the study area is shown on Table B-6.

TABLE B-6
TOTAL PERSONAL AND PER CAPITA INCOME OF THE STUDY AREA

Year	Total personal income (in millions)	Per capita income (in dollars)
	$	$
1930	96.9	353
1940	136.5	457
1950	223.9	840
1960	275.5	1,139
1965 (estimated)	311.8	1,325
1980 (projected)	433.2	1,731
2015 (projected)	1,088.7	2,873

Source: Economic Base Study of the Pascagoula, Pearl and Big Black River Basins Study Area, Volumes I and II, Michael Baker, Jr., Inc.

(b) Total personal income is made up of five major components. The sum of wage and salary income, property income, proprietorship income, transfer payments, and other personal contributions for social insurance equals total personal income. (The breakdown of total personal income by major sources is shown on Table B-7.) Wage and salary income has accounted for the largest share of personal income and will continue to do so in the future. Wage and salary includes income of employees in farm and nonfarm business in addition to several other minor components.

TABLE B-7
TOTAL PERSONAL INCOME BY MAJOR SOURCES IN THE STUDY AREA
(in millions) 1/

Year	Total income	Wage & salary income	Other labor income	Proprietors income	Property income	Transfer payments	Less social insurance
	$	$	$	$	$	$	$
1930	96.6	48.2	0.4	32.3	12.8	3.1	0.2
1940	136.4	68.4	3.0	47.7	12.7	5.4	0.8
1950	223.9	112.8	1.8	67.6	17.5	26.9	2.7
1960	275.4	166.0	5.1	55.8	25.8	29.8	7.1
1965 (est)	311.8	192.0	5.8	58.7	31.0	32.8	8.5
1980 (proj)	433.2	282.5	8.0	67.5	49.6	52.3	26.7
2015 (proj)	1,088.7	752.0	22.0	138.4	127.7	134.7	86.1

1/ In 1962 dollars.

Source: Economic Base Study of the Pascagoula, Pearl and Big Black River Basins Study Area, Volumes I and II, Michael Baker, Jr., Inc.

(5) Households of the study area. The 1960 composition of a household consisted of all persons occupying a housing unit. A housing unit includes a house, an apartment, a group of rooms, a single room, trailers, camps, boats, and railroad cars when occupied as separate living quarters. Out-migration of family farming groups from the study area during the period 1940 to 1960 caused a definite decline in the number of households. This decline is expected to continue until after 1965 at which time an increase is forecast, due largely to the overflow of Jackson's residential areas in the study area. The number of households in the study area is shown on Table B-8.

TABLE B-8
NUMBER OF HOUSEHOLDS IN THE STUDY AREA

Year	Number
1930	67,100
1940	75,300
1950	69.400
1960	63,700
1965 (estimated)	62,600
1980 (projected)	68,600
2015 (projected)	111,500

Source: Economic Base Study of the Pascagoula, Pearl and Big Black River Basins Study Area, Volumes I and II, Michael Baker, Jr., Inc.

(6) Summation of general economic growth. The study area is characterized by a predominantly rural, sparsely populated economy. Its growth has been and is expected to continue to be affected by lack of employment opportunities resulting from the gradual changeover from an agricultural to a diversified economy. The influences of the western portion of Hinds County and Warren County are expected to check past economic declines before 1980.

c. Agriculture - past, present, and future.

(1) Number and average size of farms. The total number of farms in the study area has realized a steady and rapid decline since 1944. As the total number of farms has decreased, the average size of farms has increased steadily and becomes an important factor in determining the structure of the industry in the area. The decline in number and rise in average size of farms is forecast to continue through 2015. The number and average size of farms in the study area is shown on Table B-9.

TABLE B-9
NUMBER AND AVERAGE SIZE OF FARMS IN THE STUDY AREA

Year	Number of farms	Average size of farms (acres)
1944	37,184	99.6
1949	33,750	111.7
1954	29,325	128.7
1959	18,911	176.4
1980 (projected)	8,800	360.0
2015 (projected)	7,700	380.0

Source: United States Census of Agriculture, 1939, 1949, 1954, and 1959.

(2) Number of farms by class. Another important facet in determining the economic importance of agriculture to the study area is by trend in number of farms by economic class. This trend is shown in Table B-10.

TABLE B-10
NUMBER OF FARMS BY CLASS IN THE STUDY AREA

Class 1/	1959	Projected 1980	Projected 2015
Commercial:	10,963	5,500	5,200
Class I	240	300	300
Class II	256	300	400
Class III	543	400	500
Class IV	945	600	900
Class V	3,068	1,500	1,300
Class VI	5,911	2,400	1,800
Part-time farms	4,996	2,200	2,100
Part-retirement farms	2,887	1,100	400
Total	18,846	8,800	7,700

1/ Class I - Sales of $40,000 and over.
Class II - Sales of $20,000 to $39,999.
Class III - Sales of $10,000 to $19,999.
Class IV - Sales of $5,000 to $9,999.
Class V - Sales of $2,500 to $4,999.
Class VI - Sales of $50 to $2,499 (provided the farm operator was under 65 years of age, and (1) did not work off farm 100 or more days and (2) income received in household from nonfarm sources was less than total value of farm products sold.)

Source: United States Census of Agriculture, 1939, 1949, 1954, and 1959.

(3) Total land use. The agricultural land base for the study area has fluctuated between 3.0 and 3.5 million acres for census years since 1934. The projections of the agricultural land base for 1980 and 2015 are essentially within these limits, although they show a slight decline after 1980. Major land uses within the study area for 1958-1959, and projections to 1980 and 2015, are shown in Table B-11, along with the trends in the changing structure of the different land uses. The projected decrease in the agricultural land base will be placed into nonagricultural land uses.

TABLE B-11

TOTAL LAND USE IN THE STUDY AREA (ACRES) 1/

Land Use	1958-1959	Projected 1980	Projected 2015
Agricultural:	4,238,400	4,210,900	4,036,900
Farmland	3,063,587	3,168,200	2,929,900
Harvested cropland	540,099	500,000	418,000
Pastured cropland	351,300	374,200	325,000
Idle cropland	122,340	100,000	101,200
Woodland	1,322,350	1,450,000	1,342,000
Pasture	611,846	640,000	653,700
Other land	115,652	104,000	90,000
Forest land (not on farms)	1,174,813	1,022,700	1,107,000
Nonagricultural:	228,700	256,200	430,200
Federal land (nonforest)	24,600	13,900	14,900
Urban and build-up areas	168,800	200,000	370,000
Water areas	35,300	42,300	45,300
Total Land Area	4,467,100	4,467,100	4,467,100

1/ Includes all of Hinds County.

Source: United States Census of Agriculture, 1959.

(4) Percentage of crop distribution. The total acreage devoted to the major crops of the study area and the percentage of crop distribution is presented in Table B-12.

TABLE B-12

ACREAGE OF CROPS HARVESTED AND PERCENTAGE OF CROP DISTRIBUTION IN THE STUDY AREA

Crop	Thousand Acres 1954	1959	1980	2015	Percentage 1954	1959	1980	2015
Cotton	247	172	169	183	34.7	31.9	33.8	43.8
Corn	225	174	80	43	31.7	32.2	16.0	10.3
Soybeans	55	60	101	76	7.7	11.1	20.2	18.2
Oats	42	27	31	20	5.9	5.0	6.2	4.8
Hay	78	67	79	63	11.0	12.4	15.8	15.0
Fruits, Veg., Nuts & other	64	40	40	33	9.0	7.4	8.0	7.9
Total	711	540	500	418	100.0	100.0	100.0	100.0

Source: United States Census of Agriculture, 1959.

(5) Crop yields. Crop yields per acre in the study area have shown a healthy increase in the past. This trend is predicted to continue and will reach an alltime high in 2015. The past and projected future yields of the major crops in the study area are presented in Table B-13.

TABLE B-13
CROP YIELDS OF MAJOR CROPS IN THE STUDY AREA

Crop	Units	1954	1959	Projected	
				1980	2015
Cotton	lb lint/acre	353	510	651	929
Corn	bu/acre	13.8	31.1	45	65
Soybean	bu/acre	11	21	27	37
Oats	bu/acre	34	37	51	60
Hay	tons/acre	1.03	1.47	2.0	3.0

Source: Derived from United States Census of Agriculture, 1959.

(6) Receipts by source. Cash receipts from farm marketings for 1954, 1959, and projections for 1980 and 2015 are presented in Table B-14. Gross receipts for cotton have always far exceeded any other single item in agriculture. Projected cash intake indicates that farm marketing receipts will continue to be dominated by cotton crops. The only item ever to exceed cotton is the combined livestock and livestock products. This item is, however, a combination of all livestock and livestock associated products.

3. THE FLOOD PLAIN

a. General.

(1) The economy of the Big Black River flood plain is primarily dependent upon agriculture. From all indications it will continue to be predominantly influenced by agriculture and its related development. For this reason, the discussion herein is confined to the flood plains agricultural resource. Physical characteristics affecting agriculture will be discussed as they relate to crop distribution, yields, and net returns.

(2) The principal problem in the area is flooding. Flood damages have resulted in crop losses, reduced yields, added production costs, and replacement and maintenance cost to fixed improvements. Persistent threats of flooding reduce the input of technology into crop and pasture production.

TABLE B-14
CASH RECEIPTS (GROSS) FROM FARM MARKETINGS
(in $1,000)

Item	1954	1959	Projected 1980(1)	Projected 2015(2)
Crops:				
Cotton	40,320	33,459	34,575	53,466
Corn	414	1,586	1,236	959
Soybeans	1,338	2,477	5,812	6,002
Oats	395	313	879	670
Forestry products	1,543	2,274	2,500	3,000
Other crops (2)	1,752	1,449	2,049	2,298
Livestock and livestock products (3)	16,530	31,238	36,199	56,643
Total	62,292	72,796	83,250	123,038

Source: Derived from U. S. Census of Agriculture, 1959.

(1) 1959 dollars.

(2) Includes hay, vegetables, greenhouse and nursery, fruits and nuts, and miscellaneous other crops.

(3) Includes cattle, calves, dairy products, hogs and pigs, poultry and poultry products, and miscellaneous other livestock and livestock products.

b. Delineation of the flood plain and general characteristics. The flood plain, that land subject to flooding from the Big Black River by the twenty-five year frequency storm, comprises approximately 211,000 acres. The upper end of the flood plain begins in the southeastern part of Webster County, extends in a southwesterly direction about 262 river miles to the Mississippi River near Grand Gulf in Claiborne County, and has an average width of about two miles. This plain has been divided into reaches for study and evaluation purposes from the upper to the lower end. These reaches are as follows:

(1) Kilmichael Reach - mile 213.0 to mile 262.0.

(2) West Reach - mile 162.0 to mile 213.0.

(3) Bentonia Reach - mile 92.0 to mile 162.0.

(4) Bovina Reach - mile 0.0 to mile 92.0.

c. Size, location and soils associations by reach.

(1) Kilmichael reach is 49 river miles in length and totals 45,500 acres with 10,500 acres cleared and 35,000 acres in woods. The flood plain width varies from 1/2 mile at the upper end to 3-1/2 miles near the lower end and averages about two miles. Counties in this reach are Webster, Choctaw, Montgomery, and Carroll.

(2) West reach is 51 river miles long and totals 48,000 acres with 11,100 acres of cleared land and 36,000 acres in woods. The flood plain width varies at intervals from 1-1/2 miles to 2-1/2 miles in width and averages 2 miles wide. Counties in this reach are Attala and Holmes.

(3) Bentonia reach is 70 river miles in length and totals 69,000 acres with 16,200 acres of cleared land and 52,800 acres in woods. The flood plain varies at intervals from 1-1/2 miles to 2-1/2 miles, and the average width is 2 miles. Counties in this reach are Madison and Yazoo.

(4) Bovina reach averages 1-3/4 miles wide along 92 river miles and the width varies from 1/2 mile near Bovina to 3 miles near the lower end of the reach. Counties in this reach are Hinds, Warren, and Claiborne. There are 8,100 acres of cleared land, 40,400 acres of wood land, and a total of 48,500 acres.

(5) Loessial land resource areas within the Big Black River Basin have contributed a major influence to soil characteristics and associations in the flood plain. Approximately 75 percent of the Big Black alluvium is predominantly loessial. These loessial bottom land soils total more than 350,000 acres, including upland valleys. Soil series are Falaya, Waverly, and Collins.

(6) Loessial bottom land soils are relatively uniform, medium textured and are conducive to easy breaking and cultivation. Herbicides are more effective on uniform soils for adequate weed control. Water infiltration and water-holding capacity of loessial alluvium renders these soils important for high production of locally-grown crops and desirable for the application of irrigation water.

(7) Approximately 25 percent of the flood plain is coastal plain alluvium and is located principally in the Kilmichael reach. The soils work well and produce high yields of locally-grown crops under good land management. Dominant soils series are Mantachie, Bibb and Iuka.

(8) The lower part of the Bovina reach extends into the Mississippi River flood plain. Soils in this portion are southern Mississippi alluvium with Commerce, Tunica, Bowdre, Sharkey, and Dowling, the predominant soil series. The soils produce high yields of adapted crops.

(9) Soils that are more capable of sustained high production under intensive use are the moderately-well and somewhat poorly drained association. Soil series in this association are Collins, Iuka, Commerce, and Bowdre, which are moderately-well drained; and Falaya, Mantachie, and Tunica which are somewhat-poorly drained. These soils occur along the main river streams and old abandoned channels.

(10) Soils associated with poorly-drained internal conditions are Waverly, Bibb, Sharkey, and Dowling. These soils occur on flat or depressed areas away from old or existing channels and are adapted to most locally-grown crops.

(11) The existing flood hazard and inadequate drainage prevents the utilization of otherwise productive land resources in the Big Black River flood plain.

d. Agriculture in the flood plain.

(1) Flood duration and frequency are factors which affect land use and crop distribution. Flooding from the Big Black River may have a duration of one day, or more than one month, and may occur during any month during the year. Floods that inundate lands for long periods usually occur during winter and early spring. The frequency of flooding varies by reach. Table B-15 gives frequency and extent of flooding by reach for cleared, wooded, and total land.

(2) Land devoted to agricultural uses in the basin study area is approximately 58 percent forest land, 22 percent cropland, and 15 percent pasture land. In the flood plain, land use distribution is 78 percent forest land, 11 percent cropland, and 9 percent pasture land.

TABLE B-15
BIG BLACK RIVER FLOOD PLAIN
PRESENT CONDITION
ACRES INUNDATED
BY FREQUENCY OF FLOOD

Station and Reach	River Stage Gage Reading	Total Flood Plain Acres	Total Acres Flooded	Cleared Land Flooded	Wood Land Flooded	Total Cleared Land in Flood Plain	Percent Total Land Flooded	Percent Cleared Land Flooded
TWO YEAR FREQUENCY FLOOD								
Kilmichael	14.6	45,500	35,500	4,700	30,800	10,500	78	45
West	20.3	48,000	37,500	5,900	31,600	11,100	78	53
Bentonia	27.3	69,000	55,000	4,000	51,000	16,200	80	25
Bovina	37.2	48,500	44,750	6,900	39,850	8,100	92	85
Basin Total		211,000	172,750	21,500	153,250	45,900	82	47
TEN YEAR FREQUENCY FLOOD								
Kilmichael	16.3	45,500	41,750	8,300	33,450	10,500	92	79
West	23.4	48,000	46,250	10,800	35,450	11,100	96	97
Bentonia	30.9	69,000	64,750	12,000	52,750	16,200	94	74
Bovina	39.6	48,500	47,750	7,900	39,850	8,100	98	98
Basin Total		211,000	200,500	39,000	161,500	45,900	95	85
TWENTY-FIVE YEAR FREQUENCY FLOOD								
Kilmichael	17.3	45,500	45,500	10,500	35,000	10,500	100	100
West	25.1	48,000	48,000	11,100	36,900	11,100	100	100
Bentonia	33.2	69,000	69,000	16,200	52,800	16,200	100	100
Bovina	40.2	48,500	48,500	8,100	40,400	8,100	100	100
Basin Total		211,000	211,000	45,900	165,100	45,900	100	100

(3) Average yields of crops grown in the flood plain and the average yields for 1954 and 1959 in the basin study area vary. Average yields of corn and soybeans in the flood plain are greater than the average yields of these crops in the basin study area. Average cotton yields are less in the flood plain than in the study area. Cotton, a long-season crop, is subject to greater yield reductions when planted after normal spring flood dates. Potential crop yields are considerably higher in the flood plain due to the higher productive capacity of bottomland soils. Average annual equivalent yields under existing conditions are the average yields expected to prevail for the foreseeable future in the flood plain under present flooding conditions.

(4) Average annual equivalent yields, normalized prices, and normalized costs were used to calculate net returns for crops grown in the flood plain. These budgets are to be interpreted as the average net return expected under present flooding conditions for the foreseeable future.

e. Projected agriculture under flood free conditions. Under flood free conditions the flood plain would develop at a rapid pace due to the highly productive bottomland soils and expected returns to land. Extensive land clearing and a moderate change in cropland distribution would be expected due to recent developments in soybean production.

APPENDIX C
BIG BLACK RIVER BASIN
FLOOD CONTROL BENEFITS

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PLATES

APPENDIX C
BIG BLACK RIVER BASIN
FLOOD CONTROL BENEFITS

1. GENERAL

a. This appendix contains a discussion of benefits computed for each of the plans of improvement considered for the comprehensive flood control development of the Big Black River. The Corps' responsibility for flood control in the comprehensive survey was limited to the main stem portion, i.e., the flood plain of the Big Black River. Plans of improvement considered included reservoirs, various size channel improvements, levees, and navigation channels. Benefits were also determined for these plans in combination with the Soil Conservation Service's floodwater retnetion structures.

b. The order of presentation in this appendix is as follows: (1) the method of analysis used for estimating flood control benefits; (2) calculations of flood control benefits including flood damages prevented and increases in net returns to land; and (3) a summary of flood control benefits.

2. METHOD OF ANALYSIS

a. Delineation of the flood plain by reaches.

(1) The flood plain of the Big Black River was divided into four reaches to facilitate the development of flood control benefits. All hydraulic data including stage area curves, stage frequency curves, stage reduction curves, etc., and all basic economic data furnished by the Department of Agriculture was developed for the following reaches:

(a) Kilmichael Reach - mile 213.0 to mile 262.0.

(b) West Reach - mile 162.0 to mile 213.0.

(c) Bentonia Reach - mile 92.0 to mile 162.0.

(d) Bovina Reach - mile 0.0 to mile 92.0.

(2) The area subject to flooding by the 25-year frequency storm under existing conditions was designated as the flood plain for each reach for the analysis presented herein. Protection against the 25-year frequency storm would provide a degree of protection sufficient for maximum agricultural development. Any benefits computed on lands given protection from some higher frequency storm in an agricultural area would be arbitrary and open to criticism. The area subject to flooding by the 25-year frequency storm was used to delineate the flood plain in lieu of the maximum storm of record so that benefit

computations for each reach would be on a comparative basis. (Frequencies of the maximum storms of record for the four reaches vary from 10 to 26 years.) Cleared, wooded, and total acreages in the flood plain for each reach are as follows:

Reach	Cleared Acreage	Wooded Acreage	Total Acreage
Kilmichael	10,500	35,000	45,500
West	11,100	36,900	48,000
Bentonia	16,200	52,800	69,000
Bovina	8,100	40,400	48,500
Flood plain	45,900	165,100	211,000

b. Flood damages and flood damages prevented.

(1) Crop damages and damages prevented. Crop damages and damages prevented for alternative plans of improvement considered were computed using an electronic computer program developed by the Vicksburg District entitled "Damages to Crops from Multiple Floods Per Year." 1/ The Department of Agriculture furnished basic input data for this program including crop distributions, average annual equivalent yields, preharvest production costs, and overhead and management costs for the various crops farmed in the flood plain by reach. Season crop damage factor curves used in the computer program to determine flood damages in the flood plain are shown on Plates C-1, C-2, C-3, and C-4. All crop budgets used in the program were developed using normalizes prices as presented in the April 1966 booklet entitled "Interim Price Standards for Planning and Evaluating Water and Land Resources." Floods of record for the period 1941-1965 were analyzed by reach to determine average annual crop damages and damages prevented.

(2) Noncrop damages and damages prevented. Noncrop damage curves (Plates C-5, C-6, C-7, and C-8) for each reach were developed for the purpose of estimating noncrop damages and damages prevented. An inventory of all real estate improvements at various elevations in the flood plain by reach served as the basis for determining damages at various river stages. As with crop damages, floods of record for the period 1941-1965 were analyzed by reach to determine average annual noncrop damages prevented.

c. Increase in net returns to land.

(1) General. Flood protection, whether full or partial, resulting for any plan of improvement considered would reduce the financial risks involved in any farming enterprise. The reduction of financial risks would afford better land management practices which

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1/ Program developed by Walter T. Miller, June 1961, File No. 61-13-1401.

would result in higher yields and subsequent higher net returns to land. Increases in net returns to lands were estimated from yield and cost of production data developed by the Department of Agriculture. Enterprise budgets for the various crops by reach for existing and flood-free conditions served as the basis for these estimates (Table C-4). Enterprise budgets and subsequent net returns to lands for existing and flood-free conditions were based on average annual equivalent yields for existing and flood-free conditions, normalized prices, and normalized costs of production. Increases in returns to cleared lands were estimated as the difference in (1) net returns under existing conditions, and (2) net returns under flood-free conditions, adjusted. Increases in returns to wooded lands were estimated as adjusted net returns under flood-free conditions minus existing net returns to woodlands and development costs. Where full flood protection was not provided by any of the alternative plans of improvement considered, increases in net returns were adjusted to reflect the flood protection provided. Increases in net returns to woodlands were discounted 15 years to allow for an assumed period of development.

(2) Flood frequency zones. For each improvement plan considered, lands in the flood plain by reach were zoned depending on the degree of protection provided. The zoning was then used as a basis for adjusting net return estimates to reflect various degrees of development expected for the plans of improvement considered. Flood frequency zones determined for each alternative plan of improvement considered were as follows:

(a) A-Zone - Land given total protection from the 25-year frequency storm with the alternative plan of improvement in place.

(b) B_1-Zone - Land between the 25- and 10-year flood frequency stage with the alternative plan of improvement in place.

(c) B_2-Zone - Land between the 10- and 2-year flood frequency stage with the alternative plan of improvement in place.

(d) C-Zone - Land below the 2-year flood frequency stage with the alternative plan of improvement in place.

(3) Adjustments in net returns for partial protection. The increases in net return to cleared and wooded land by reach were adjusted to reflect less than full protection afforded by the alternative plans of improvement considered. Lands within the A-Zone were allotted the full increase in net return from existing to flood free conditions. Lands in the B_1 and B_2 zones were reduced to 90 and 50 percent of this increase to account for lack of participation and remaining flood damage. No increase in net returns to lands was assumed to take place on C-Zone lands due to the high risks involved. It is felt that the real breaking point between partial and full development would lie between the 10- and 25-year frequency flowline.

That is, lands that are subject to flooding every 10-25 years or less would be developed to a stage comparable to flood-free lands but below that point the probability of flooding would become a limiting factor. These assumptions are made in light of the high costs of production necessary for high yields and subsequent high net returns and was the reason for reducing the net return differential between existing and flood-free conditions 10, 50, and 100 percent on B_1, B_2, and C-Zone lands, respectively.

(4) Woodland to be cleared. The amount of woodland expected to be cleared and placed into cultivation as a result of any improvement considered was based on the percent of total land in the Big Black River flood plain cleared at present under various flood risk situations. A check was made to see what percentage of the total land was cleared on land that (1) had no flood problem, (2) land that was flooded every 10-25 years, and (3) land that was flooded every 2-10 years. Roughly, 90 percent, 60 percent, and 60 percent of the total land was cleared in categories 1, 2, and 3, respectively. Since the recent land clearing rate has been stepped up to put more land in soybean production, additional clearing is anticipated over and above what is cleared now under the various risk situations presented above, 90 percent, 80 percent, and 70 percent of the lands in Zones A, B_1, and B_2, respectively, were assumed to be cleared for each improvement considered. The high productive capabilities of bottom land soils found in the Big Black River flood plain were also considered in projecting clearing rates.

3. FLOOD CONTROL BENEFITS

a. Flood damages prevented. Using the method of analysis described herein, flood damages and flood damages prevented were estimated for the alternative improvements considered. Flood damages under existing conditions by reach and flood damages prevented by tributary reservoirs are shown in Table C-1. Flood damages prevented for the tributary reservoirs are presented in detail as an example. A summary of crop damages and noncrop damages prevented for all plans of improvement considered by reach is presented in Tables C-2 and C-3, respectively. Average annual flood damages under existing conditions are as follows for the flood plain as a whole:

Average annual crop damage:	$151,600
Average annual noncrop damage:	83,700
Total average annual damage:	$235,300

Damages in any given year have ranged from no damage to nearly $500,000.

b. Increases in net returns to land.

(1) General. Weighted net returns to land were developed by reach for average annual equivalent yields under existing and flood-free conditions. Weighted increases in net returns to cleared and

APPENDIX C
TABLE C-1
FLOOD DAMAGES UNDER EXISTING CONDITIONS AND FLOOD DAMAGES PREVENTED
FOR TRIBUTARY RESERVOIRS
KILMICHAEL REACH

(Flooding begins at stage 11.8)

Occurrence		EXISTING CONDITIONS						TRIBUTARY RESERVOIRS					
Year	Month	Gage * Height (Feet)	Acres flooded Total	Acres flooded Cleared	Crop damage $	Non-crop damage $	Total damage $	Gage Height (Feet)	Acres flooded Total	Acres flooded Cleared	Crop damage $	Non-crop damage $	Total damage $
1941	Jul-Nov-Dec	13.3	30,700	2,100	28,500	11,000	39,500	13.0	29,500	1,600	15,100	9,500	24,600
1942	Feb-Mar-Dec	14.0	33,200	3,400	4,800	14,100	18,900	13.7	32,200	2,900	2,700	9,800	12,500
1943	Mar	13.3	30,700	2,100	3,700	5,100	8,800	13.0	29,500	1,600	2,400	4,300	6,700
1944	Mar-Apr-May	15.7	39,800	7,100	51,900	26,800	78,700	15.1	37,200	5,800	40,900	22,800	63,700
1945	Feb-Mar-Apr	14.7	35,700	4,900	25,200	22,000	47,200	14.3	34,200	4,100	16,200	22,400	38,600
1946	Jan-Feb-Mar	13.6	31,700	2,700	12,900	18,100	31,000	14.2	34,000	3,900	3,100	12,700	15,800
1947	Mar-Apr-Jun	15.2	37,700	6,000	141,200	27,900	169,100	14.6	35,500	4,800	114,000	24,700	138,700
1948	Feb-Mar-Apr	14.7	35,700	4,900	26,400	27,000	53,400	14.3	34,200	4,100	20,500	23,900	44,400
1949	Apr-May-Jun	16.3	41,700	8,400	50,500	38,200	88,700	15.5	39,000	6,600	35,600	31,700	67,300
1950	Mar-Jun-Aug	15.6	39,200	6,900	77,200	36,000	113,200	14.9	36,500	5,400	58,000	31,700	89,900
1951	Mar-Apr-Jun	17.3	45,500	10,500	60,000	36,400	96,400	16.3	41,700	8,400	39,800	31,200	71,000
1952	Feb-Mar-Apr	13.0	29,700	1,600	6,900	13,700	20,600	12.6	27,500	1,100	3,300	11,200	14,500
1953	Mar-Apr-May	14.3	34,200	4,100	64,000	22,200	86,200	14.0	33,200	3,400	45,600	20,000	65,600
1954	Jan-Feb-May	14.1	33,700	3,700	40,100	11,500	51,600	13.8	32,500	3,000	32,100	9,800	41,900
1955	Feb-Mar-Apr	14.8	36,200	5,200	31,100	13,800	44,900	14.3	34,200	4,100	24,400	12,000	36,400
1956	Mar-Apr-May	14.0	33,200	3,400	21,500	22,800	44,300	13.7	32,200	2,900	14,900	19,800	34,700
1957	Apr-Jun-Jul	14.8	36,200	5,200	66,200	29,000	95,200	14.3	34,200	4,100	44,600	22,000	66,600
1958	Mar-Apr-May	14.5	35,100	4,500	47,400	18,300	65,700	14.1	33,700	3,700	37,200	15,300	52,500
1959	Feb-Apr-Dec	14.4	34,500	4,300	20,700	13,000	33,700	14.0	33,200	3,400	16,000	11,500	27,500
1960	Jan-Feb-Mar	14.1	33,700	3,200	5,800	15,700	21,500	13.8	32,500	3,000	3,800	13,300	17,100
1961	Mar-Apr-Jul	13.8	32,500	3,000	24,900	20,100	45,000	15.5	39,000	6,600	12,100	15,700	27,800
1962	Jan-Feb-Apr	13.5	31,500	2,500	5,000	8,000	13,000	13.2	30,200	2,000	2,600	6,700	9,300
1963	Jul-Dec	13.5	31,500	2,500	63,500	5,000	68,500	13.2	30,200	2,000	50,800	2,900	53,700
1964	Feb-Mar-Apr	13.7	32,200	2,900	26,000	15,300	41,300	13.4	31,000	2,300	20,400	13,300	33,700
1965	Feb-Mar-Apr	15.3	38,000	6,300	11,100	15,300	26,400	14.6	35,500	4,800	8,000	11,500	19,500
Total (25 years)					916,500	486,300	1,402,800				664,000	410,000	1,074,000
Average Annual Flood Damages					36,700	19,500	56,200				26,500	16,400	43,000
Flood Damage Prevented											10,200	3,100	13,300

* For maximum flood during period. Lesser floods which occurred are not shown.

APPENDIX C
TABLE C-1 (con.)
FLOOD DAMAGES UNDER EXISTING CONDITIONS AND FLOOD DAMAGES PREVENTED
FOR TRIBUTARY RESERVOIRS
WEST REACH

(Flooding begins at stage 17.6)

Occurrence		EXISTING CONDITIONS						TRIBUTARY RESERVOIRS					
Year	Month	Gage * Height (Feet)	Acres flooded Total	Acres flooded Cleared	Crop damage	Non-crop damage	Total damage	Gage Height (Feet)	Acres flooded Total	Acres flooded Cleared	Crop damage	Non-crop damage	Total damage
					$	$	$				$	$	$
1941	Nov	18.0	11,500	350	1,200	5,900	7,100	-	-	-	-	-	-
1942	Dec	18.7	16,000	1,100	400	6,900	7,300	18.0	11,500	350	100	5,900	6,000
1943	-	-	-	-	-	-	-	-	-	-	-	-	-
1944	Feb-Mar-May	23.3	46,200	10,730	141,900	38,900	180,800	21.5	42,000	8,850	112,900	30,500	143,400
1945	Feb-Mar	20.0	35,700	4,700	8,600	24,200	32,800	19.0	21,700	1,500	3,000	20,500	23,500
1946	Jan-Feb-Mar	22.7	45,100	10,350	9,000	36,800	45,800	21.1	40,700	8,100	5,900	20,600	25,500
1947	Jan-Apr-Jun	22.1	43,700	9,700	178,800	42,400	221,200	20.6	39,000	6,300	81,800	32,600	114,400
1948	Feb-Mar-Apr	22.0	43,500	9,600	21,100	49,700	70,800	20.6	39,000	6,800	9,100	35,300	44,400
1949	Feb-Mar-May	23.9	47,000	10,950	38,900	73,700	112,600	21.9	43,200	9,500	16,400	34,700	51,100
1950	Feb-Mar-Sep	20.4	38,100	6,200	23,500	42,600	66,100	19.9	35,000	4,300	7,500	24,200	31,700
1951	Feb-Mar-Apr	24.1	47,200	11,050	44,100	84,100	128,200	22.0	43,500	9,600	30,900	44,400	75,300
1952	Mar	19.7	33,000	3,400	4,200	8,400	12,600	18.8	17,500	1,200	1,500	7,000	8,500
1953	Feb-Apr-May	19.0	21,700	1,500	19,700	20,500	40,200	18.3	13,000	600	6,500	12,700	19,200
1954	May	20.5	38,700	6,600	76,000	9,700	85,700	19.4	29,000	2,200	25,300	7,900	33,200
1955	Feb-Mar-Apr	20.7	39,400	7,100	41,800	24,100	65,900	19.6	31,700	3,000	17,600	20,300	37,900
1956	Feb-Mar-Apr	19.6	31,700	3,000	12,000	37,300	49,300	18.7	16,000	1,100	4,300	31,700	36,000
1957	Jan-Apr-Nov	21.6	42,300	9,000	68,400	26,700	95,100	20.2	3,700	5,500	40,500	16,500	57,000
1958	Apr-May	20.7	39,400	7,100	71,700	16,300	88,000	19.6	31,700	3,000	29,700	8,300	38,000
1959	Feb-Apr-Dec	19.2	25,500	2,000	16,300	22,700	39,000	18.4	13,500	700	5,700	19,400	25,100
1960	Jan-Feb-Mar	19.7	33,000	3,400	3,500	20,600	24,100	18.8	17,500	1,200	1,200	12,800	14,000
1961	Feb-Mar-Nov	20.3	37,700	5,900	29,200	64,100	93,300	22.0	43,500	9,600	11,100	35,100	46,200
1962	Feb-Mar-Apr	20.0	35,700	4,700	6,700	41,600	48,300	19.0	21,700	1,500	1,500	25,900	27,400
1963	Mar-Jul	19.4	28,000	2,200	70,900	14,000	84,900	18.6	15,000	1,000	32,000	6,700	38,700
1964	Jan-Mar-Apr	19.7	33,000	3,400	33,100	43,300	76,400	18.8	17,500	1,200	11,700	26,500	38,200
1965	Feb-Mar	22.5	44,700	10,200	9,600	36,200	45,800	20.6	39,000	6,800	4,800	22,300	27,100
Total (25 years)					930,700	790,700	1,721,400				461,000	501,800	961,800
Average Annual Flood Damage					37,200	31,600	68,800				18,300	20,100	38,500
Flood Damages Prevented											18,900	11,500	30,400

* For maximum flood during period. Lesser floods which occurred are not shown.

APPENDIX C
TABLE C-1 (con.)
FLOOD DAMAGES UNDER EXISTING CONDITIONS AND FLOOD DAMAGES PREVENTED
FOR TRIBUTARY RESERVOIRS
BENTONIA REACH

(Flooding begins at stage 23.6)

Occurence		EXISTING CONDITIONS						TRIBUTARY RESERVOIRS					
Year	Month	Gage * Height (Feet)	Acres flooded Total	Acres flooded Cleared	Crop damage	Non-crop damage	Total damage	Gage Height (Feet)	Acres flooded Total	Acres flooded Cleared	Crop damage	Non-Crop damage	Total damage
					$	$	$				$	$	$
1941	Mar	23.9	31,600	130	200	5,300	5,500	-	-	-	-	-	-
1942	Mar-Aug-Dec	26.1	49,500	2,200	12,300	12,900	25,200	25.5	44,500	1,500	6,600	7,200	13,800
1943	Mar-Apr	24.7	38,000	700	2,000	7,000	9,000	24.2	34,000	320	1,100	2,500	3,600
1944	Feb-Mar-May	26.8	53,250	3,200	57,600	29,100	86,700	26.6	52,400	2,920	32,200	16,200	48,400
1945	Feb-Jun	27.3	55,000	400	19,400	14,400	33,800	26.7	52,700	3,100	10,900	8,200	19,100
1946	Feb-Mar-May	28.5	58,500	6,200	72,000	36,700	108,700	27.7	56,500	4,800	40,300	24,500	64,800
1947	Jan-Apr	27.7	56,500	4,800	44,200	24,700	68,900	27.0	54,000	3,500	24,600	14,200	38,800
1948	Feb-Apr-Nov	28.7	59,400	6,900	44,200	27,200	71,400	27.8	56,500	5,000	24,600	15,300	39,900
1949	Jan-Mar-May	29.8	62,200	9,600	57,900	29,400	87,300	28.8	59,700	7,100	32,800	16,500	49,300
1950	Feb-Mar-Jul	27.7	56,500	4,800	32,200	27,400	59,600	27.0	54,000	3,500	18,000	15,600	33,600
1951	Feb-Mar-Apr	31.6	66,250	13,600	84,500	46,300	130,800	30.0	62,600	10,000	50,700	26,400	77,100
1952	Jan	24.2	34,000	320	100	3,400	3,500	23.7	30,000	-	-	1,700	1,700
1953	Feb-Mar-Apr	26.9	53,750	3,400	60,500	19,400	79,900	26.4	51,400	2,600	33,400	11,000	44,400
1954	May	27.7	56,500	4,800	55,000	8,400	63,400	27.0	54,000	3,500	31,100	4,900	36,000
1955	Feb-Mar-Apr	27.5	55,750	4,400	30,600	15,200	45,800	27.0	54,000	3,500	16,900	8,700	25,600
1956	Feb-Mar-Apr	27.4	55,500	4,200	35,500	25,800	61,300	26.8	53,250	3,200	19,700	14,500	34,200
1957	Feb-Apr-Jun	28.2	58,000	5,800	57,700	25,100	82,800	27.4	55,500	4,200	31,700	14,200	45,900
1958	Jan-Mar-Apr	30.6	64,000	11,400	153,600	29,700	183,300	29.4	61,500	8,600	92,000	16,800	108,800
1959	Feb-Apr-Dec	25.7	46,250	1,700	13,100	14,800	27,900	25.2	42,000	1,200	7,100	8,100	15,200
1960	Jan-Feb-Mar	26.7	52,700	3,100	13,400	20,200	33,600	26.5	52,000	2,750	7,300	11,300	18,600
1961	Feb-Jun-Nov	31.3	65,500	12,900	32,400	41,100	73,500	30.0	62,600	10,000	18,000	24,900	42,900
1962	Jan-Feb-Apr	27.7	56,500	4,800	35,200	20,700	55,900	27.0	54,000	3,500	20,200	11,600	31,800
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	Mar-Apr	26.9	53,750	3,400	27,200	12,800	40,000	26.4	51,400	2,600	15,300	7,200	22,500
1965	Feb-Mar	28.1	57,700	5,600	20,500	14,300	34,800	27.1	54,400	3,700	11,500	8,100	19,600
Total (25 years)					961,300	511,000	1,472,000				546,000	289,600	835,600
Average Annual Flood Damages					38,500	20,400	58,900				217,000	11,600	33,400
Flood Damage Prevented											16,800	8,800	25,600

* For maximum flood during period. Lesser floods which occurred are not shown.

APPENDIX C
TABLE C-1 (con.)
FLOOD DAMAGES UNDER EXISTING CONDITIONS AND FLOOD DAMAGES PREVENTED
FOR TRIBUTARY RESERVOIRS
BOVINA REACH

(Flooding begins at stage 31.1)

Occurrence		EXISTING CONDITIONS						TRIBUTARY RESERVOIRS					
Year	Month	Gage * Height (Feet)	Acres flooded Total	Acres flooded Cleared	Crop damage	Non-crop damage	Total damage	Gage Height (Feet)	Acres flooded Total	Acres flooded Cleared	Crop damage	Non-crop damage	Total damage
					$	$	$				$	$	$
1941	Jan	33.2	31,500	3,800	1,700	2,400	4,100	-	-	-	-	-	-
1942	-	-	-	-	-	-	-	-	-	-	-	-	-
1943	Jan	32.0	24,300	2,000	900	1,600	2,500	-	-	-	-	-	-
1944	Feb-Mar	34.0	36,500	4,800	37,300	17,500	54,800	33.6	34,000	4,400	34,000	10,800	44,800
1945	Feb	36.0	42,600	6,250	30,900	4,800	35,700	34.1	37,200	4,900	24,300	3,000	27,300
1946	Jan-Feb-May	39.1	47,200	7,700	41,800	23,100	64,900	38.4	46,300	7,400	22,900	15,800	38,700
1947	Jan-Apr	38.0	45,700	7,250	68,400	14,700	83,100	36.8	44,000	6,700	63,200	10,700	73,900
1948	Feb-Mar-Nov	38.6	46,500	7,500	29,700	19,000	48,700	37.7	45,300	7,150	25,700	13,600	39,300
1949	Feb-Mar-May	39.3	47,400	7,750	89,800	27,800	117,600	38.6	46,500	7,500	73,000	16,500	89,500
1950	Jan-Feb-Mar	37.8	45,500	7,170	30,100	16,800	46,900	36.6	43,600	6,600	25,100	11,700	36,800
1951	Jan-Feb-Mar	39.8	48,000	7,920	53,100	32,600	85,700	39.3	47,400	7,750	49,900	22,600	72,500
1952	-	-	-	-	-	-	-	-	-	-	-	-	-
1953	Mar-Apr	37.6	45,200	7,100	125,100	9,500	134,600	36.2	43,000	6,350	110,100	6,300	116,400
1954	May	33.4	33,000	4,200	52,400	2,500	54,900	31.1	18,600	200	2,600	1,200	3,800
1955	Apr	37.2	44,500	6,900	39,600	6,300	45,900	35.7	42,200	6,050	35,000	4,400	39,400
1956	Feb-Mar-Apr	36.8	44,000	6,700	52,400	17,000	69,400	36.5	43,500	6,600	45,200	10,500	55,700
1957	Feb-Nov	38.0	45,700	7,250	36,000	9,200	45,200	36.8	44,000	6,700	32,900	6,100	39,000
1958	Apr	39.5	77,500	7,800	100,400	20,000	120,000	38.9	46,800	7,600	99,200	11,500	110,700
1959	-	36.2	43,000	6,350	-	-	-	-	-	-	-	-	-
1960	Feb-Mar	34.6	39,500	5,300	20,500	8,000	28,500	34.2	38,200	5,100	15,100	4,800	19,900
1961	Feb-Mar-Dec	34.5	39,300	5,250	49,600	31,800	81,400	32.6	28,000	3,000	25,600	21,900	47,500
1962	Jan-Apr	37.6	45,200	7,100	47,100	12,800	59,900	36.2	43,000	6,350	42,100	9,100	51,200
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	Mar-Apr	35.7	42,200	6,050	63,600	14,900	78,500	33.8	35,200	4,600	39,500	9,600	49,100
1965	Feb	38.4	46,300	7,400	10,300	12,300	22,600	37.8	45,500	7,150	8,600	9,700	18,300
Total (25 years)					980,700	304,600	1,285,300				774,000	201,300	975,300
Average Annual Flood Damages					39,200	12,200	51,400				30,900	8,000	38,900
Flood Damage Prevented											8,300	4,200	12,500

* For maximum flood during period. Lesser floods which occurred are not shown.

APPENDIX C
TABLE C-2
AVERAGE ANNUAL CROP DAMAGES AND CROP DAMAGES PREVENTED BY REACH FOR ALTERNATIVE PLANS CONSIDERED

Reach	Existing damages	PLANS CONSIDERED									
		Edwards main stem reservoir	Tributary reservoirs	SCS floodwater retarding structures	Tributary reservoirs with SCS structures in place	Main stem channel improvement 3-yr. freq.	Main stem channel improvement 3-yr. freq. with SCS structures in place	Main stem channel improvement 1-yr. freq.	Main stem channel improvement 1-yr. freq. with SCS structures in place	Local protection projects	
										Goodman loop levee	Apookta loop levee
	$	$	$	$	$	$	$	$	$	$	$
Kilmichael	36,700	-	26,500	34,600	22,100	11,000	3,400	16,900	13,[illegible]00	36,700	36,700
West	37,200	-	18,300	33,800	12,400	5,000	1,500	14,700	8,000	33,700	35,200
Bentonia	38,500	-	21,700	30,400	18,500	12,100	3,800	25,700	17,000	38,500	38,500
Bovina	39,200	24,900	30,900	26,400	26,300	6,600	2,100	26,100	22,000	39,200	39,200
Total residual damages	151,600		97,400	125,200	79,300	34,700	10,800	82,400	60,700	148,100	149,600
Crop damages prevented		14,500 1/	54,200	26,400	72,300	116,900	140,800	69,200	90,900	3,500	2,000

1/ Edwards main stem reservoir prevents damages only in the Bovina reach.

APPENDIX C

TABLE C-3

AVERAGE ANNUAL NON-CROP DAMAGES AND NON-CROP DAMAGES PREVENTED BY REACH FOR ALTERNATIVE PLANS CONSIDERED

Reach	Existing damages	PLANS CONSIDERED									
		Edwards main stem reservoir	Tributary reservoirs	SCS floodwater retarding structures	Tributary reservoirs with SCS structures in place	Main stem channel improvement 3-yr. freq.	Main stem channel improvement 3-yr. freq. with SCS structures in place	Main stem channel improvement 1-yr. freq.	Main stem channel improvement 1-yr. freq. with SCS structures in place	Local protection projects: Goodman loop levee	Local protection projects: Apookta loop levee
	$	$	$	$	$	$	$	$	$	$	$
Kilmichael	19,500	-	16,400	17,600	15,500	2,600	700	4,300	4,100	19,500	19,500
West	31,600	-	20,100	23,900	20,300	4,800	1,000	11,300	8,600	30,600	30,800
Bentonia	20,400	-	11,600	16,900	11,400	5,200	1,100	12,900	10,100	20,400	20,400
Bovina	12,200	4,900	8,000	9,700	7,100	1,400	300	5,900	4,400	12,200	12,200
Total residual damages	83,700	-	56,100	68,000	54,300	13,900	3,100	34,400	27,200	82,700	82,900
Non-crop damages prevented		7,300 1/	27,600	15,800	29,400	69,900	80,600	49,300	56,500	1,000	800

1/ Edwards main stem reservoir prevents damages only in the Bovina reach.

APPENDIX C
TABLE C-4
WEIGHTED INCREASE IN NET RETURNS PER ACRE FOR CLEARED AND WOODED LAND
(KILMICHAEL REACH)

Item	Crop	Normalized unit price	Average annual Equivalent yield	Value per acre	Distribution	Weighted value	Overhead and management cost	Pre-harvest cost	Harvest cost	Total cost	Distribution	Weighted costs	Weighted value -weighted cost	Weighted returns
Weighted net returns, flood-free conditions:														
	Cotton &	.258/lb	675	204.02	10	20.40	24.48	71.61	71.81	167.90	10	16.79		
	Seed	48.96/T	0.61T											
	Corn	1.21/bu	90	108.90	26	28.31	13.06	45.53	13.92	72.51	26	18.85		
	Soybeans	2.47/bu	32	79.04	5	3.95	9.48	29.87	7.54	46.89	5	2.34		
	*Pasture	21.27/cwt	320	68.06	50	34.03	8.16		28.18	36.34	50	18.17		
	Idle & other	-	-	-	9	-	-	-	-	-	9	-		
Total weighted value						86.69							86.69	
Total weighted cost												56.15	56.15	
Weighted net returns													30.54	30.54
Weighted net returns, existing conditions:														
	Cotton &	.258/lb	575	173.81	10	17.38	20.86	64.48	62.33	147.67	10	14.77		
	Seed	48.96/T	0.52T											
	Corn	1.21/bu	60	72.60	23	16.70	8.72	34.18	10.92	53.82	23	12.38		
	Soybeans	2.47/bu	26	64.22	1	.64	7.70	25.31	7.00	40.01	1	.40		
	*Pasture	21.27/cwt	220	46.79	57	26.67	5.62		21.80	27.42	57	15.63		
	Idle & other	-	-		9	-	-	-	-	-	9	-		
Total weighted value						61.39							61.39	
Total weighted cost												43.18	43.18	
Weighted net returns													18.21	18.21
Increase in weighted net returns to cleared land:														12.20
Increase in weighted net returns to woodland:														
Weighted net returns, flood-free conditions														30.54
Less existing net returns to woodland														3.50
Less development cost (Table C-5)														4.66
Increase in net returns to woodland														22.38
Discounted 15 years for development (.7578)														16.96

*Lbs of beef produced per acre.

APPENDIX C

TABLE C-4 (con.)

WEIGHTED INCREASE IN NET RETURNS PER ACRE FOR CLEARED AND WOODED LAND

(WEST REACH)

Item	Crop	Normalized unit price	Average annual Equivalent yield	Value per acre	Distribution	Weighted value	Overhead and management cost	Pre-harvest cost	Harvest cost	Total cost	Distribution	Weighted costs	Weighted value -weighted cost	Weighted returns
Weighted net returns, flood-free conditions:														
	Cotton &	.258/lb	775	234.22	13	30.45	28.10	78.75	85.45	192.30	13	25.00		
	Seed	48.96/T	0.70T											
	Corn	1.21/bu	95	114.95	24	27.56	13.80	47.08	14.42	75.30	24	18.07		
	Soybeans	2.47/bu	35	86.45	12	10.37	10.38	32.05	7.98	50.41	12	6.05		
	*Pasture	21.27/cwt	340	72.32	42	30.37	8.68	29.18		37.86	42	15.09		
	Idle & other	-	-	-	9	-	-				9			
Total weighted value						98.75							98.75	
Total weighted cost												65.02	65.02	
Weighted net returns													33.73	33.73
Weighted net returns, existing conditions:														
	Cotton &	.258/lb	650	196.59	13	25.56	23.60	69.86	70.40	163.86	13	21.30		
	Seed	48.96/T	0.59T											
	Corn	1.21/bu	60	72.60	19	13.79	8.72	34.18	10.92	53.82	19	10.23		
	Soybeans	2.47/bu	28	64.16	6	4.15	8.30	26.87	7.14	42.31	6	2.54		
	*Pasture	21.27/cwt	260	55.30	53	29.31	6.64	24.25		30.89	53	16.37		
	Idle & other	-	-	-	9	-	-	-	-	-	9	-		
Total weighted value						72.81							72.81	
Total weighted cost												50.44	50.44	
Weighted net return													22.37	22.37
Increase in weighted net returns to cleared land:														11.55
Increase in weighted net returns to woodland:														
Weighted net returns, flood-free conditions														33.73
Less existing net returns to woodlands														3.50
Less development cost (Table C-5)														4.66
Increase in net returns to woodland														25.57
Discounted 15 years for development (.7578)														19.38

*Lbs. of beef produced per acre.

APPENDIX C
TABLE C-4 (con.)
WEIGHTED INCREASE IN NET RETURNS PER ACRE FOR CLEARED AND WOODED LAND
(BENTONIA REACH)

Item	Crop	Normalized unit price	Average annual Equivalent yield	Value per acre	Distri-bution	Weighted value	Overhead and management cost	Pre-harvest cost	Harvest cost	Total cost	Distri-bution	Weighted costs	Weighted: value -weighted cost	Weighted returns
Weighted net returns, flood-free conditions:														
	Cotton & Seed	.258/lb 48.96/T	775 .70	234.22	11	25.76	28.10	78.75	82.60	189.45	11	20.84		
	Corn	1.21/bu	95	114.95	25	28.74	13.80	47.08	14.42	75.30	25	18.83		
	Soybeans	2.47/bu	35	86.45	19	16.43	10.38	32.05	7.98	50.41	19	9.58		
	*Pasture	21.27/cwt	348	74.02	35	25.91	8.88	29.58		38.46	35	13.46		
	Idle & other	-	-	-	10	-	-	-	-	-	10	-		
Total weighted value						96.84							96.84	
Total weighted cost												62.71	62.71	
Weighted net returns													34.13	34.13
Weighted net returns, existing conditions:														
	Cotton & Seed	.258/lb 48.96/T	650 0.59/T	196.59	11	21.63	23.60	69.86	70.40	163.86	11	18.02		
	Corn	1.21/bu	60	72.60	15	10.89	8.72	34.18	70.40	53.82	15	8.07		
	Soybeans	2.47/bu	28	69.16	5	3.46	8.30	26.87	7.14	42.31	5	2.12		
	*Pasture	21.27/cwt	260	55.30	59	32.62	6.64	24.25		30.89	59	18.23		
	Idle & other	-	-	-	10	-	-	-	-	-	10	-		
Total weighted value						68.60							68.60	
Total weighted cost												46.44	46.44	
Weighted net return													22.16	22.16
Increase in weighted net returns to cleared land:														11.72
Increase in weighted net returns to woodland:														
Weighted net returns, flood free conditions														34.13
Less existing net returns to woodlands														3.50
Less development cost (Table C-5)														4.66
Increase in net returns to woodland														25.97
Discounted 15 years for development (.7578)														19.68

*lbs. of beef produced per acre.

APPENDIX C

TABLE C-4 (con.)

WEIGHTED INCREASE IN NET RETURNS PER ACRE FOR CLEARED AND WOODED LAND

(BOVINA REACH)

Item	Crop	Normalized unit price	Average annual Equivalent yield	Value per acre	Distribution	Weighted value	Overhead and management cost	Pre-harvest cost	Harvest cost	Total cost	Distribution	Weighted costs	Weighted value -weighted cost	Weighted returns
Weighted net returns, flood free conditions:														
	Cotton & Seed	.258/lb 48.96/T	775 0.70T	234.22	9	21.08	28.10	78.75	83.96	190.81	9	17.12		
	Corn	1.21/bu	95	114.95	16	18.39	13.80	47.08	14.42	75.30	16	12.05		
	Soybeans	2.47/bu	36	88.92	29	25.79	10.68	32.73	8.19	51.60	29	14.96		
	*Pasture	21.27/cwt	348	74.02	40	29.51	8.88	29.58		38.46	40	15.38		
	Idle & other	-	-	-	6	-	-	-	-	-	6	-		
Total weighted value						94.87							94.87	
Total weighted cost												59.51	59.51	
Weighted net returns													35.56	35.56
Weighted net returns, existing conditions·														
	Cotton & Seed	.258/lb 48.96/T	700 0.63T	211.44	9	19.03	25.38	73.50	75.71	174.59	9	15.71		
	Corn	1.21/bu	60	72.60	16	11.62	8.72	34.18	10.92	53.82	16	8.61		
	Soybeans	2.47/bu	30	74.10	1	.74	8.90	28.43	7.26	44.59	1	.45		
	Pasture	21.27/cwt	260	55.30	68	37.66	6.64	24.25		30.89	68	21.00		
	Idle & other	-	-	-	6	-	-	-	-	-	6	-		
Total weighted value						69.05							69.05	
Total weighted cost												45.77	45.77	
Weighted net return													23.28	23.28
Increase in weighted net returns to cleared lands:														12.08
Increase in weighted net returns to woodland:														
Weighted net returns, flood free conditions														35.56
Less existing net returns to woodland														3.50
Less development cost (Table C-5)														4.66
Increase in net returns to woodland														27.40
Discounted 15 years for development (.7578)														20.74

*Lbs. of beef produced per acre.

wooded lands by reach under flood-free conditions are shown in Table C-4. Development costs associated with woodland being cleared are given in Table C-5.

TABLE C-5
DEVELOPMENT COST PER ACRE FOR WOODLAND TO BE CLEARED AND DEVELOPED FOR PRODUCTION

Clearing costs:			
First cost:	$75.00		
Average annual:			
Interest and amortization at 3-1/4 percent for 50 years (.04073)		=	$3.05
Drainage costs:			
First cost:			
Group laterals	$ 4.60		
On farm	9.00		
Total	$13.60		
Average annual:			
Interest and amortization at 3-1/4 percent for 10 years (.11873)		=	1.61
Total average annual development cost			$4.66

(2) Crop distributions. Estimates made by the Department of Agriculture and reported in the economic base study indicate that the crop distribution of the basin is to experience only moderate change. The flood plain of the Big Black River is also expected to have only a moderate change in crop distribution as a result of any project considered. A relatively small increase in soybean acreage is expected since the heavier bottom land soils are well suited for this crop. Crop distributions under existing conditions and for future conditions are shown in Table C-4.

(3) Flood frequency zones. Cleared land, including woodland to be cleared (acres benefited), for flood frequency zones for each alternative plan considered, is shown in Table C-6. This table can be used to compare the relative amount of flood protection provided by each alternative plan. Comparisons of each alternative plan's relative flood protection can be made by comparing the area benefited by each plan in Zones A, B_1, and B_2. The flood frequency zones served as the basis for adjusting increases in net returns for alternative plans of improvement considered as set forth in paragraph 2c(2) above.

TABLE C-6

AREAS BENEFITED FROM ALTERNATIVE IMPROVEMENTS CONSIDERED
(CLEARED LAND AND WOODED LAND TO BE CLEARED)

Improvements considered	Area totally protected	Area partially protected		
	Zone A Area totally protected from 25-year frequency flood with project in place (Acres)	Zone B_1 Area between 25- and 10-year frequency flood with project in place (Acres)	Zone B_2 Area between 10- and 2-year frequency flood with project in place (Acres)	Total area benefited Zone A, + Zone B_1 + Zone B_2 (Acres)
Edwards main stem reservoir	351	624	15,834	16,809
Tributary reservoirs	10,300	9,000	25,235	44,535
SCS floodwater retarding structures	7,375	9,200	21,560	38,135
Tributary reservoirs with SCS structures in place	14,925	8,000	28,350	51,275
Main stem channel improvement, 3 yr. frequency	4,860	11,900	108,640	125,400
Main stem channel improvement, 3 yr. freq. with SCS structures in place	14,650	12,920	115,570	143,140
Main stem channel improvement, 1 yr. frequency	1,725	10,000	45,325	57,050
Main stem channel improvement, 1 yr. freq. with SCS structures in place	9,150	10,200	92,925	112,275
Local protection projects:				
Goodman loop levee	1,800	180	150	2,130
Apookta loop levee	830	320	140	1,290

(4) Adjustment in net returns for partial protection. Table C-7 shows the increase in net returns adjusted for each reach for partial protection both for cleared land and woodland to be cleared, as discussed in paragraph 2c(3) above. Total increase in net returns to land for each alternative plan considered is the product of the adjusted net returns and the number of acres cleared and expected to be cleared in Zones A, B_1, and B_2. Benefits associated with increases in net returns to land for the tributary reservoirs are shown in detail in Table C-8 as an example.

TABLE C-7
ADJUSTMENTS FOR INCREASES IN NET RETURNS PER ACRE
FOR LESS THAN FLOOD-FREE CONDITIONS BY REACH
AND FOR FREQUENCY ZONES CONSIDERED

Reach	Increases in net returns per acre					
	Flood-free conditions		Less than flood-free conditions			
	A-Zone		B_1 Zone		B_2 Zone	
	Cleared land	Woodland to be cleared	Cleared land	Woodland to be cleared	Cleared land	Woodland to be cleared
	$	$	$	$	$	$
Kilmichael	12.20	16.96	10.98	15.26	6.10	8.48
West	11.55	19.38	10.40	17.44	5.78	9.69
Bentonia	11.72	19.68	10.55	17.71	5.86	9.84
Bovina	12.08	20.74	10.87	18.67	6.04	10.87

(5) Total and cleared land distributions. Table C-9 shows the cleared and wooded land distributions computed for each alternative plan using the method of analysis set forth in paragraph 2c(4) above. This table also shows the number of acres assumed to be cleared as a result of each alternative plan.

(6) Comparison of market values of land and capitalized net income estimates. Average land values in the flood plain at present are $175 and $75.00 an acre for cleared and woodland, respectively. The average increase in net return for the tributary reservoirs, as presented in Table C-8, is $8.27 and $13.10 for cleared and wooded land, respectively. These values, capitalized by the formula $V = \frac{R}{r}$, where:

V = Capitalized value (the per acre average increase in value of land protected).

R = Annual average increase in net returns.

r = Interest rate.

Item	Kilmichael					
	Zone A	Zone B_1	Zone B_2	Zone C	Zone A	Zon
Existing conditions:						
Cleared acres	2,100	2,000	2,700	3,700	700	1,4
Wooded acres	1,650	1,250	2,050	30,050	2,050	1,6
Total acres	3,750	3,250	4,750	33,750	2,750	3,0
With project:						
Cleared acres	3,375	2,600	3,325	3,700	2,475	2,4
Wooded acres	375	650	1,425	30,050	275	6
Total acres	3,750	3,250	4,750	33,750	2,750	3,0
Wooded acres to be cleared	1,275	600	625	0	1,775	1,0
Unit benefit: 1/	$	$	$	$	$	$
Presently cleared	12.20	10.98	6.10	0	11.55	10.4
Woodland cleared	16.96	15.26	8.48	0	19.38	17.4
Benefits:						
Cleared acres	25,620	21,960	16,470	0	8,085	14,56
Woodland acres	21,624	9,156	5,300	0	34,400	17,44
Total	47,244	31,116	21,770	0	42,485	32,00
Use		$100,000				$1

1/ See Tables C-7 and C-4.

APPENDIX C
TABLE C-8
COMPUTATIONS FOR INCREASE IN NET RETURN TO LANDS
WITH TRIBUTARY RESERVOIRS IN PLACE

	West				Bentonia				Bovina		
Zone C	Zone A	Zone B_1	Zone B_2	Zone C	Zone A	Zone B_1	Zone B_2	Zone C	Zone A	Zone B_1	Zone B
3,700	700	1,400	7,100	1,900	4,000	3,400	5,700	3,100	150	250	1,900
30,050	2,050	1,600	9,650	23,600	100	200	2,850	49,650	350	500	4,100
33,750	2,750	3,000	16,750	25,500	4,100	3,600	8,550	52,750	500	750	6,000
3,700	2,475	2,400	11,725	1,900	4,000	3,400	5,985	3,100	450	600	4,200
30,050	275	600	5,025	23,600	100	200	2,565	49,650	50	150	1,800
33,750	2,750	3,000	16,750	25,500	4,100	3,600	8,550	52,750	500	750	6,000
0	1,775	1,000	4,625	0	0	0	285	0	300	350	2,300
$	$	$	$	$	$	$	$	$	$	$	$
0	11.55	10.40	5.78	0	11.72	10.55	5.86	0	12.08	10.87	6.04
0	19.38	17.44	9.69	0	19.68	17.71	9.84	0	20.74	18.67	10.37
0	8,085	14,560	41,038	0	46,880	35,870	33,402	0	1,812	2,718	11,476
0	34,400	17,440	44,816	0	0	0	2,804	0	6,222	6,535	23,851
0	42,485	32,000	85,854	0	46,880	35,870	36,206	0	8,034	9,253	35,327
		$160,000				$119,000				$53,000	

2

TO LANDS
E

	Bovina				Basin				
Zone C	Zone A	Zone B_1	Zone B_2	Zone C	Zone A	Zone B_1	Zone B_2	Zone C ?	TOTAL
3,100	150	250	1,900	5,800	6,950	7,050	17,400	14,500	45,900
49,650	350	500	4,100	35,450	4,150	3,550	18,650	138,750	165,100
52,750	500	750	6,000	41,250	11,100	10,600	36,050	153,250	211,000
3,100	450	600	4,200	5,800	10,300	9,000	25,235	14,500	59,035
49,650	50	150	1,800	35,450	800	1,600	10,815	138,750	151,965
52,750	500	750	6,000	41,250	11,100	10,600	36,050	153,250	211,000
0	300	350	2,300	0	3,350	1,950	7,835	0	13,135
$	$	$	$	$	$	$	$	$	$
0	12.08	10.87	6.04	0	7.99	8.34	4.05	0	8.27
0	20.74	18.67	10.37	0	18.58	16.99	9.79	0	13.10
0	1,812	2,718	11,476	0	82,397	75,108	102,386	0	259,891
0	6,222	6,535	23,851	0	62,246	33,131	76,771	0	172,148
0	8,034	9,253	35,327	0	144,643	108,239	179,157	0	432,039
		$53,000				$432,000			

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APPENDIX C
TABLE C-9
LAND DISTRIBUTION AND AMOUNTS OF WOODLAND EXPECTED TO BE CLEARED BY REACH
FOR ALTERNATIVE IMPROVEMENTS CONSIDERED

Improvements	Kilmichael Reach		West Reach		Bentonia Reach		Bovina Reach		Basin		Woodland expected to be cleared
	Wooded	Cleared	Wooded	Cleared	Wooded	Cleared	Wooded	Cleared	Wooded	Cleared	
Present land use	35,000	10,500	36,900	11,100	52,800	16,200	40,400	8,100	165,100	45,900	
Edwards main stem reservoir 1/	-	-	-	-	-	-	29,900	18,600	-	-	10,500
Tributary reservoirs	32,500	13,000	29,500	18,500	52,515	16,485	37,450	11,050	151,965	59,035	13,135
SCS flood water retarding structures	32,725	12,775	33,100	14,900	52,515	16,485	38,125	10,375	151,965	59,035	13,035
Tributary reservoirs with SCS structures in place	32,125	13,375	26,800	21,200	51,775	17,225	36,325	12,175	147,025	63,975	18,075
Main stem channel improvement, 3-yr. frequency	25,685	19,815	18,300	29,700	27,515	41,485	14,100	34,400	85,600	125,400	79,500
Main stem channel improvement, 3-yr. frequency with SCS structures in place	19,420	26,080	16,110	31,890	18,400	50,600	13,990	34,510	67,860	143,140	97,240
Main stem channel improvement, 1-yr. frequency	32,675	12,825	27,700	20,300	52,275	16,725	31,600	16,900	144,250	66,750	20,850
Main stem channel improvement, 1-yr. frequency with SCS structures in place	28,875	16,625	19,350	28,650	35,975	33,025	14,525	33,975	98,725	112,275	66,375
Local protection projects: 2/											
Goodman loop levee	-	-	35,820	12,180	-	-	-	-	-	-	1,080
Apookta loop levee	-	-	36,060	11,940	-	-	-	-	-	-	840

1/ Edwards main stem reservoir affects Bovina reach only.

2/ Goodman and Apookta loop levee sites are located in West reach.

are \$138.00 and \$218.00, respectively. Adding these capitalized values to the average present values, cleared land values with the project amount to \$300.00 an acre (\$313.00 and \$293.00 for cleared and woodland to be cleared, respectively). Although detailed estimates of increases in net return for each project showing values for cleared and wooded land are not presented herein, weighted increases in net return by reach and for alternative plans considered are presented in Table C-10. These figures are to be interpreted as the average weighted increase in net returns for all land benefited by each alternative plan of improvement considered.

(7) Summary of benefits from increased net returns. A summary of benefits due to increase in net return for each alternative plan by reach is given in Table C-11. Increase in net return benefits for any alternative considered may be computed roughly by multiplying the total acres in Zones A, B_1, and B_2 (Table C-6) times the weighted average increase in net returns for the flood plain (Table C-10).

4. SUMMARY OF FLOOD CONTROL BENEFITS

Table C-12 gives a summary of the flood control benefits estimated for each alternative improvement considered including crop damages prevented, noncrop damages prevented, and increases in net returns to land. Incremental benefits for Corps of Engineers work alone have been calculated by deducting benefits estimated to accrue to the Soil Conservation Service's floodwater retention structures, where applicable.

APPENDIX C

TABLE C-10

WEIGHTED INCREASES IN NET RETURNS PER ACRE INCLUDING LANDS BENEFITED IN ZONES A, B_1, and B_2 AND CAPITALIZED VALUES BY REACH FOR ALTERNATIVE IMPROVEMENTS CONSIDERED 1/

Improvements considered	Kilmichael Reach		West Reach		Bentonia Reach		Bovina Reach		Big Black Flood Plain	
	Weighted increase in net returns	Capitalized value	Weighted increase in net returns	Capitalized value	Weighted increase in net returns	Capitalized value	Weighted increase in net returns	Capitalized value	Weighted increase in net returns	Capitalized value
	$	$	$	$	$	$	$	$	$	$
Edwards main stem reservoir	-	-	-	-	-	-	8.62	143.66	-	-
Tributary reservoirs	10.77	179.50	9.65	160.83	8.89	148.17	10.01	166.83	9.70	161.66
SCS floodwater retarding structures	10.15	169.17	9.00	150.00	8.89	148.17	10.02	167.00	9.31	155.17
Tributary reservoirs with SCS structures in place	10.96	182.67	10.20	170.00	9.32	155.33	10.08	168.00	10.12	168.70
Main stem channel improvement, 3-yr. frequency	8.35	139.71	9.24	154.00	9.00	150.00	9.94	165.67	9.19	153.17
Main stem channel improvement, 3-yr. frequency with SCS structures in place	9.20	153.33	10.09	168.16	9.48	158.00	10.17	169.50	9.73	162.16
Main stem channel improvement, 1-yr. frequency	8.68	144.67	8.56	142.67	7.61	126.83	9.29	154.83	8.52	142.00
Main stem channel improvement, 1-yr. frequency with SCS structures in place	8.97	149.50	9.43	157.17	9.13	152.17	9.62	159.50	9.31	155.17
Local protection projects:										
Goodman loop levee	-	-	14.55	242.50	-	-	-	-	-	-
Apookta loop levee	-	-	15.65	260.83	-	-	-	-	-	-

1/ Capitalized at 6 percent.

APPENDIX C

TABLE C-11

INCREASES IN NET RETURNS TO LAND BY REACH FOR ALTERNATIVE IMPROVEMENTS CONSIDERED

Reach	Plans considered									
	Edwards main stem reservoir	Tributary reservoirs	SCS floodwater retarding structures	Tributary reservoirs with SCS structures in place	Main stem channel improvement 3 yr. freq.	Main stem channel improvement 3 yr. freq. with SCS structures in place	Main stem channel improvement 1 yr. freq.	Main stem channel improvement 1 yr. freq. with SCS structures in place	Local protection projects: Goodman loop levee	Local protection projects: Apookta loop levee
	$	$	$	$	$	$	$	$	$	$
Kilmichael	-	100,000	88,000	112,000	166,000	240,000	90,000	148,000	-	-
West	-	160,000	107,000	200,000	274,000	321,800	160,000	270,000	31,000	20,200
Bentonia	-	119,000	119,000	136,000	372,000	479,800	110,000	302,000	-	-
Bovina	145,000	53,000	42,000	71,000	341,000	351,700	126,000	327,000	-	-
Total	145,000	432,000	356,000	519,000	1,153,000	1,393,300	486,000	1,046,000	31,000	20,200

APPENDIX C
TABLE C-12
SUMMARY OF FLOOD CONTROL BENEFITS FOR ALTERNATIVE PLANS OF IMPROVEMENT CONSIDERED

Item	Plans considered									
	Edwards main stem reservoir	Tributary Reservoirs	SCS[1] floodwater retarding structures	Tributary[2] reservoirs with SCS structures in place	Main stem channel improvement 3 yr. freq.	Main stem[3] channel improvement 3 yr. freq. with SCS structures in place	Main stem channel improvement 1 yr. freq.	Main stem[3] channel improvement 1 yr. freq. with SCS structures in place	Local protection projects: Goodman loop levee	Local protection projects: Apookta loop levee
	$	$	$	$	$	$	$	$	$	$
Flood damages prevented:										
Crop damages prevented	14,500	54,200	26,400	72,300	116,900	140,800	69,200	90,900	3,500	2,000
Non-crop damages prevented	7,300	27,600	15,800	29,400	69,900	80,600	49,300	56,500	1,000	800
Subtotal	21,800	81,800	42,200	101,700	186,800	221,400	118,500	147,400	4,500	2,800
Increase in net return to land	145,000	432,000	356,000	519,000	1,153,000	1,393,300	486,000	1,046,000	31,000	20,200
Total benefits	166,800	513,800	398,200	620,700	1,339,800	1,614,700	604,500	1,193,400	35,500	23,000
Less benefits to SCS structures	-	-	398,200	223,000[4]	-	398,200	-	398,200	-	-
Incremental benefits to Corps work	166,800	513,800	-	397,700	1,339,800	1,216,500[5]	604,500	795,200[5]	35,500	23,000

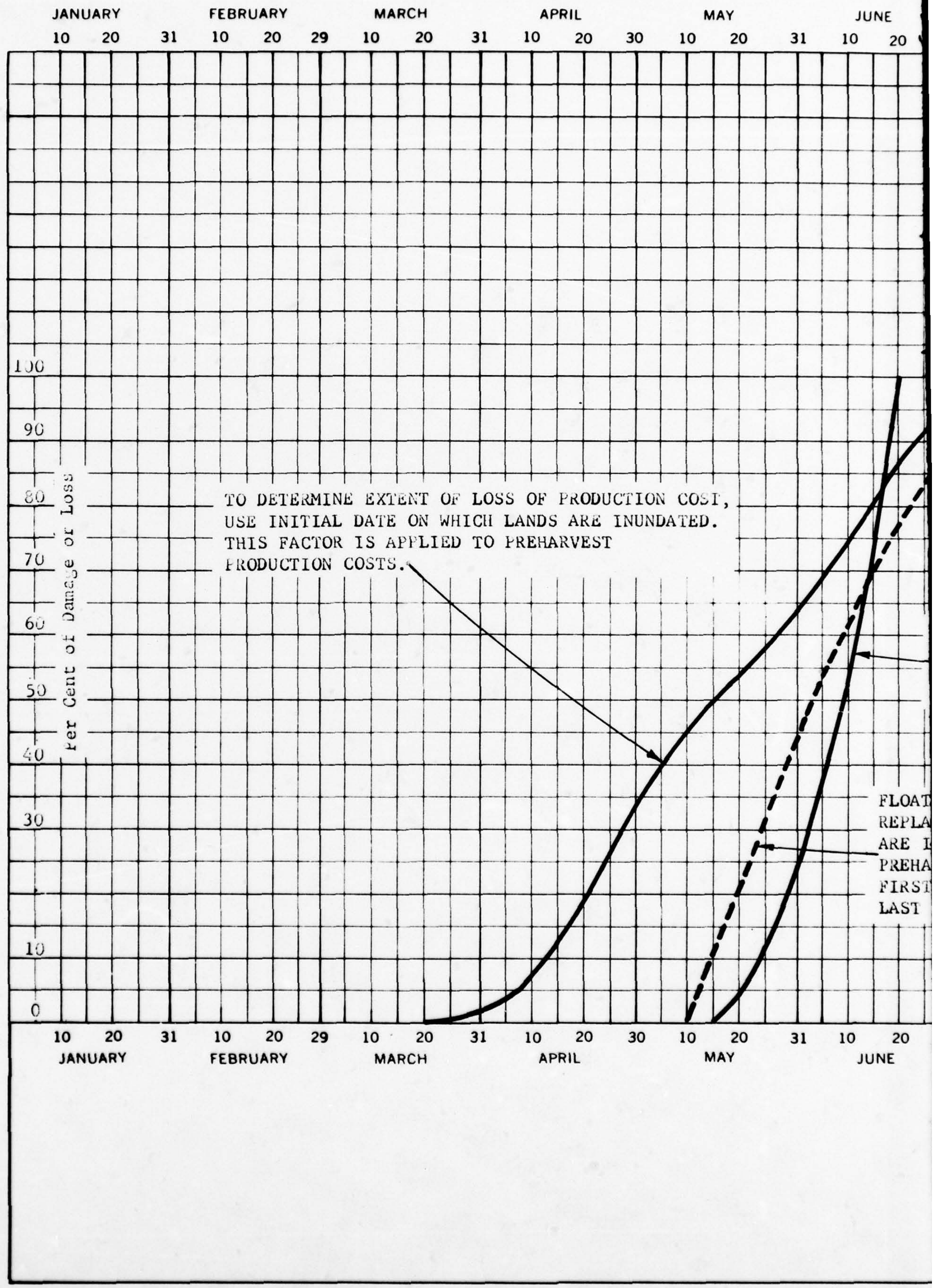
1/ Incidental main stem benefits attributable to the Soil Conservation Service's floodwater retarding structures.

2/ Floodwater retarding structures studied by Soil Conservation Service assumed in place on the tributaries not controlled by Tributary Reservoirs.

3/ All floodwater retarding structures studied by SCS assumed in place.

4/ Adjusted to reflect the number of SCS structures eliminated by the Tributary Reservoirs.

5/ Incremental benefits computed for this plan differ from the main stem channel alone since they assume SCS reservoirs in place. (The benefits are computed on the basis of stage reductions over and above the reductions that accrue to the SCS reservoirs.)



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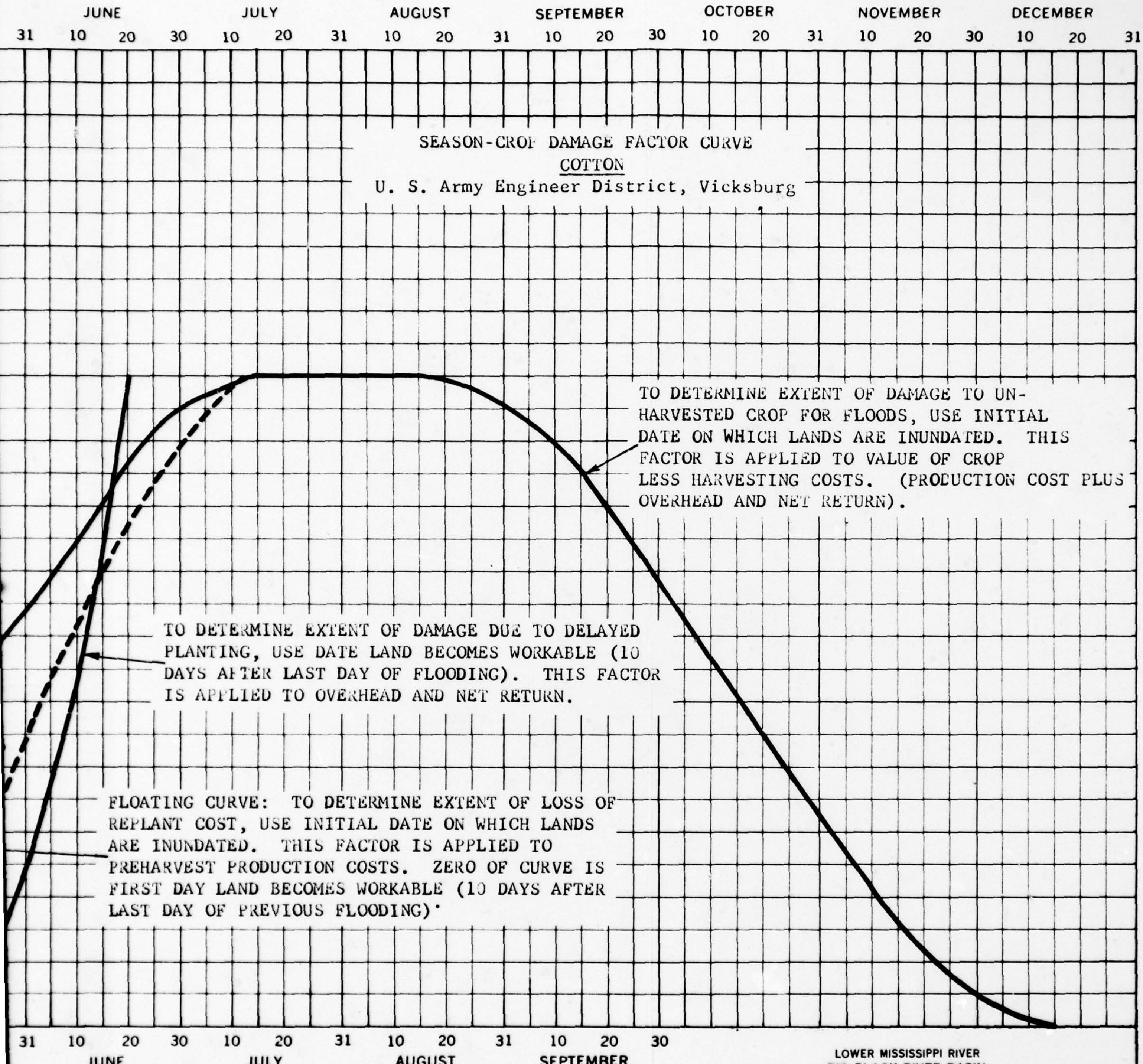


LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

SEASON - CROP DAMAGE FACTOR CURVE
COTTON

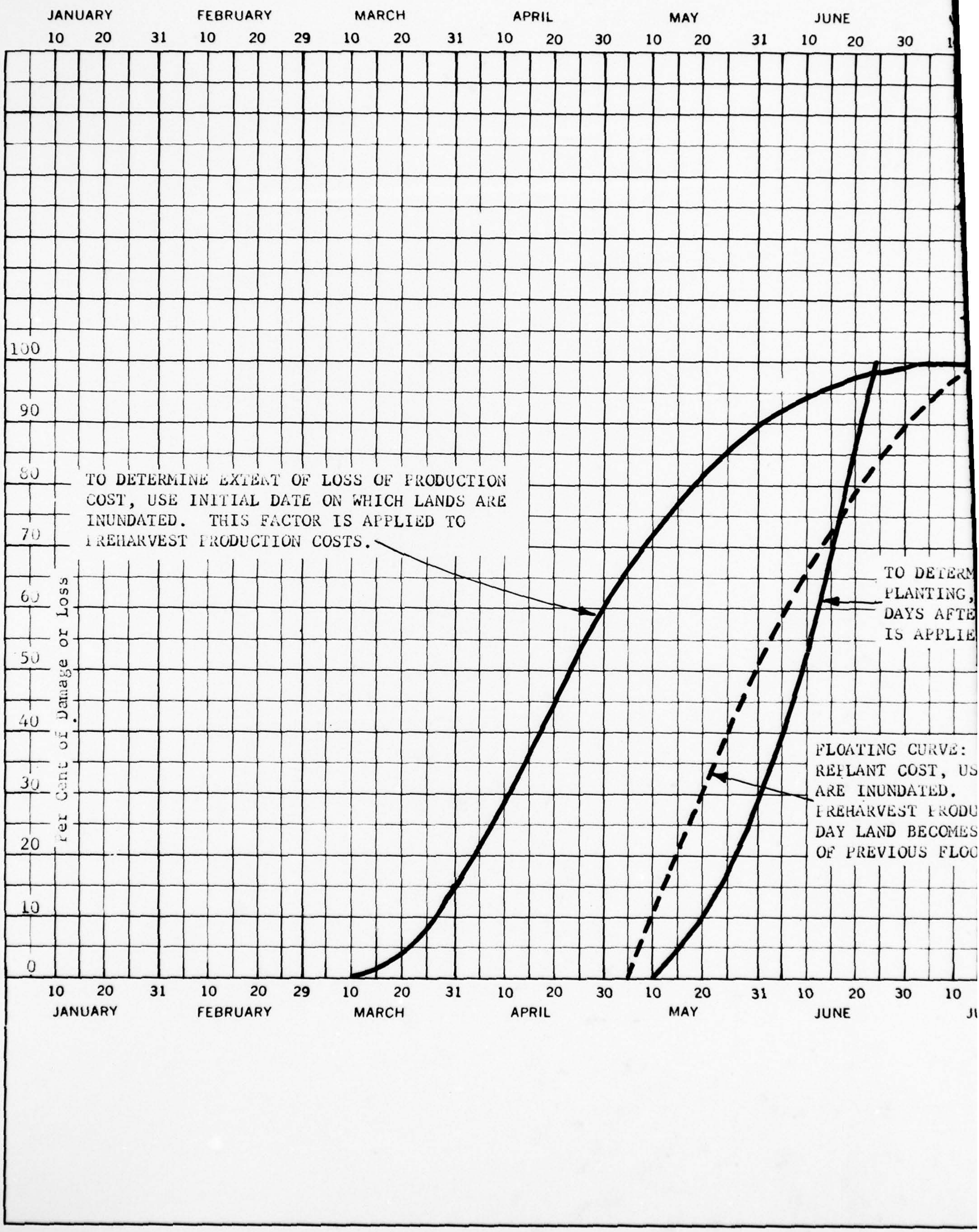
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

PLATE C-1

2



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Per Cent of Damage or Loss
TO DETERMINE EXTENT OF LOSS OF PRODUCTION COST, USE INITIAL DATE ON WHICH LANDS ARE INUNDATED. THIS FACTOR IS APPLIED TO PREHARVEST PRODUCTION COSTS.
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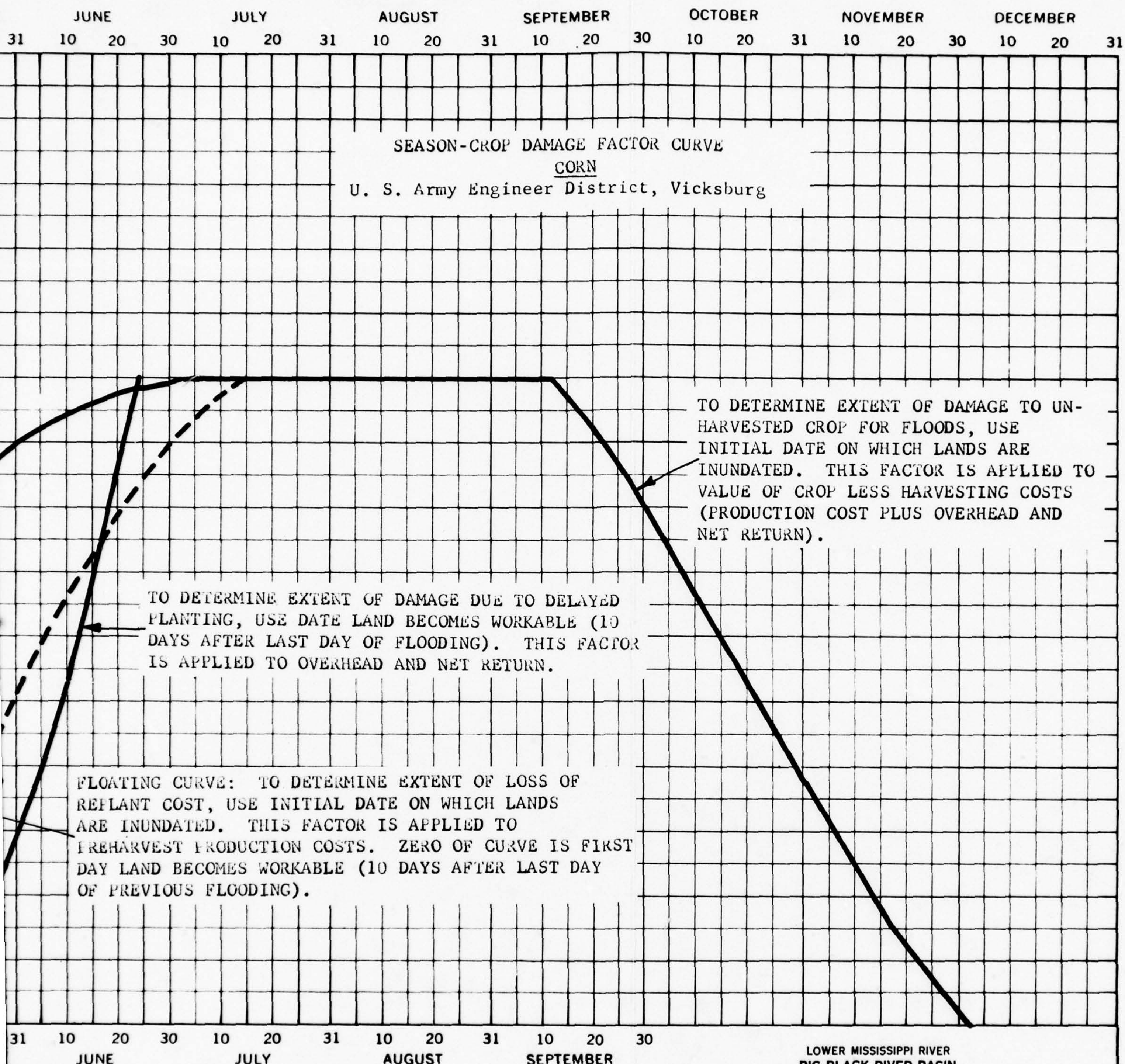


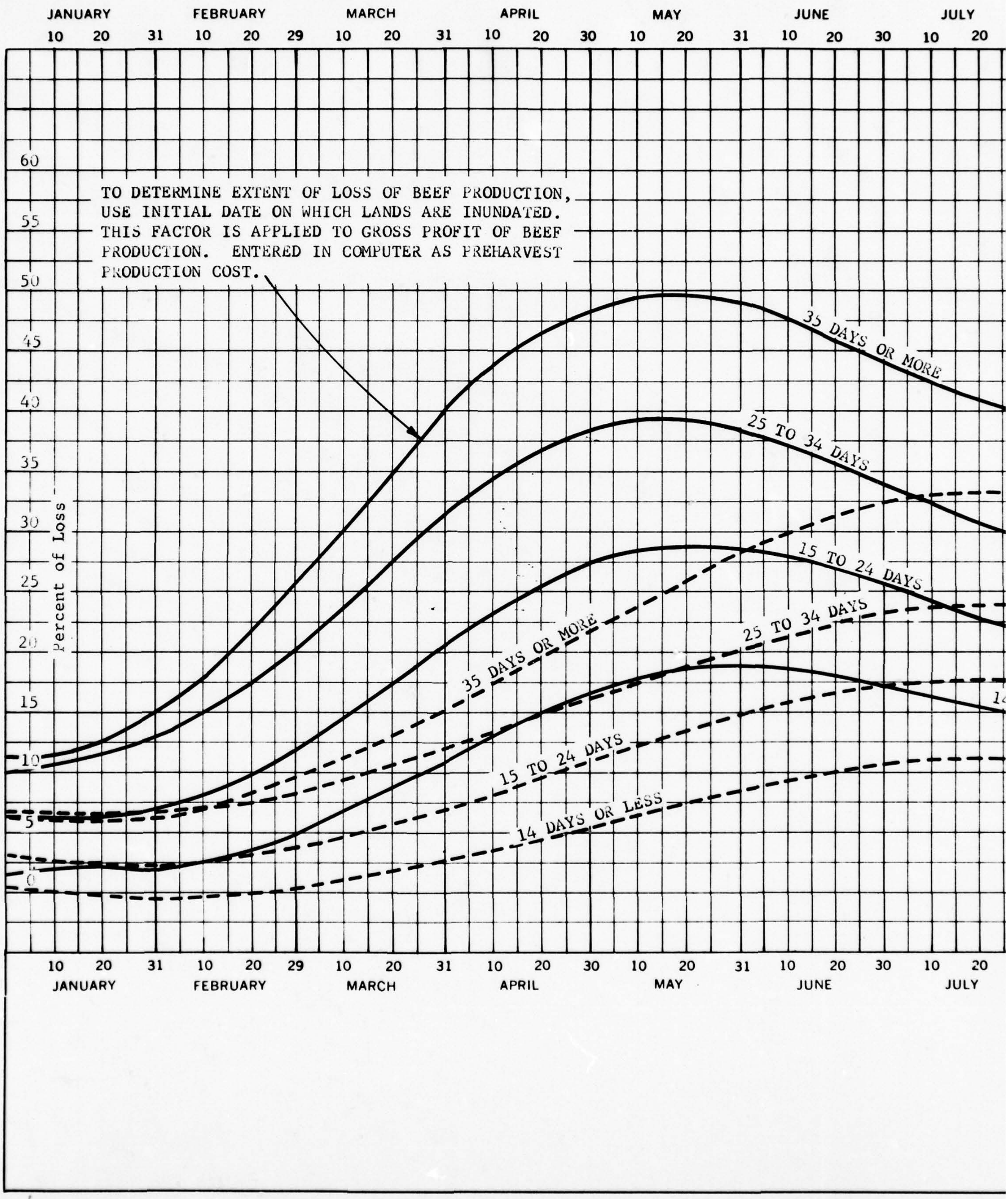
LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

SEASON - CROP DAMAGE FACTOR CURVE
CORN

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9



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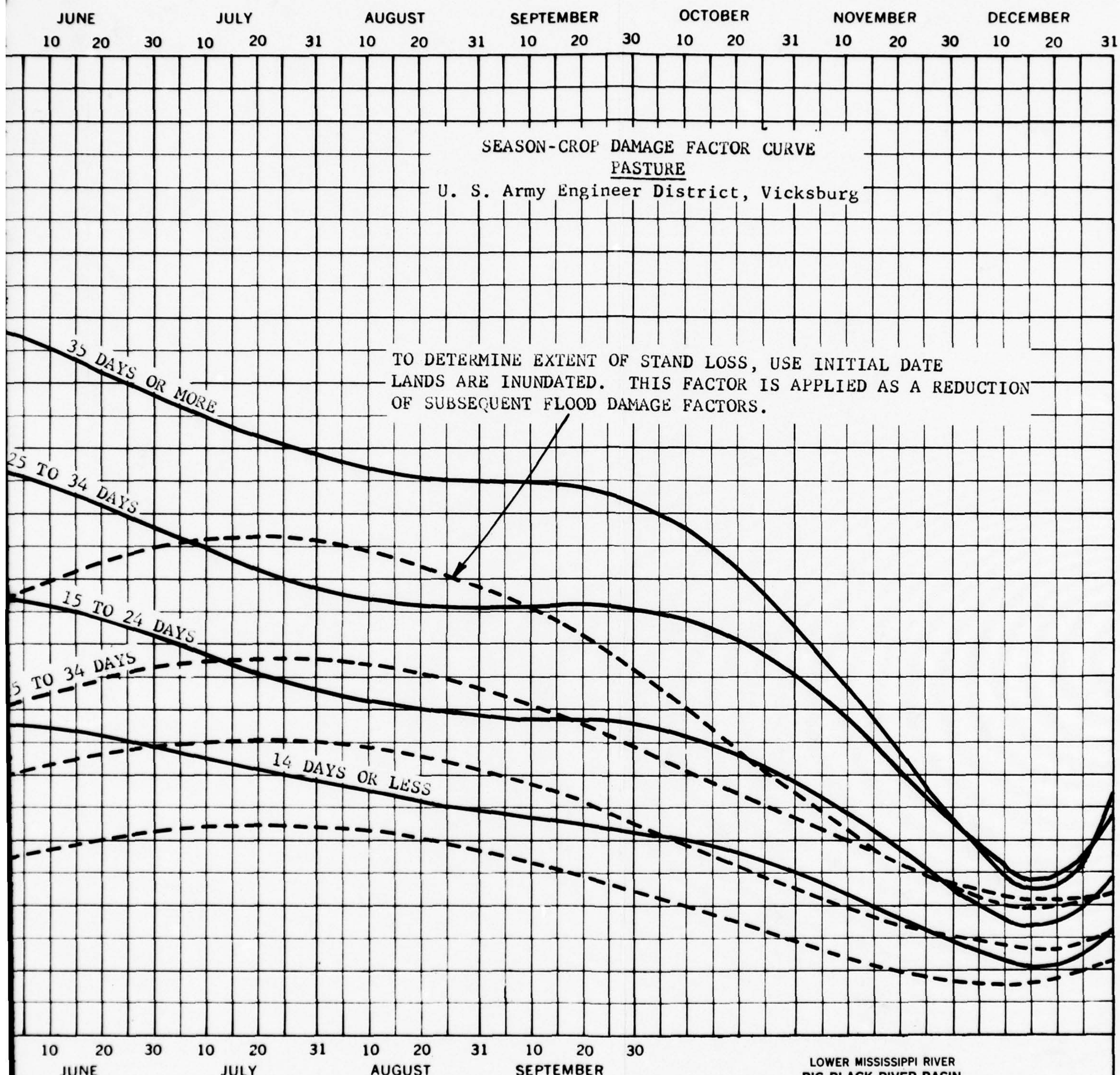


LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

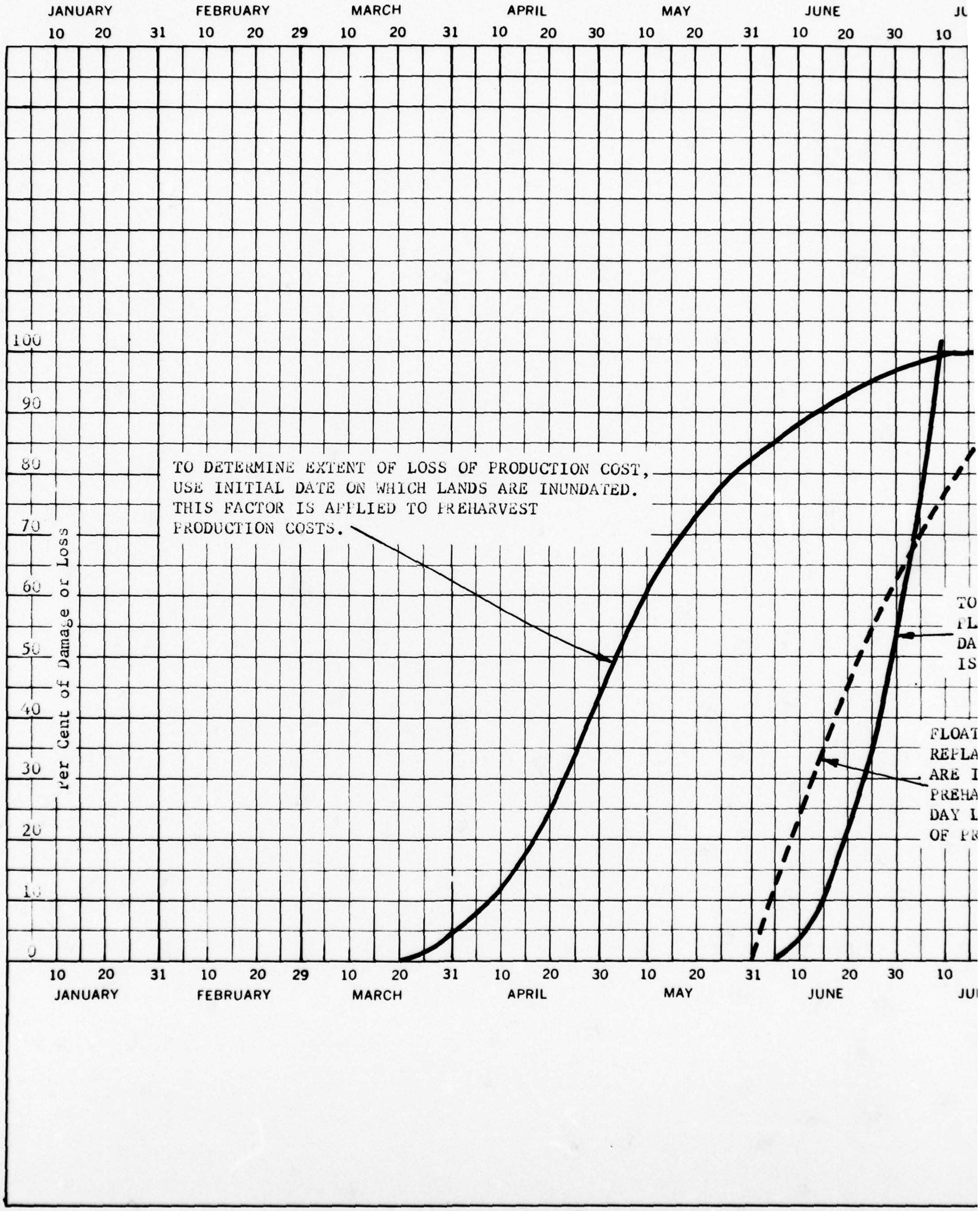
SEASON - CROP DAMAGE FACTOR CURVE
PASTURE

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

2



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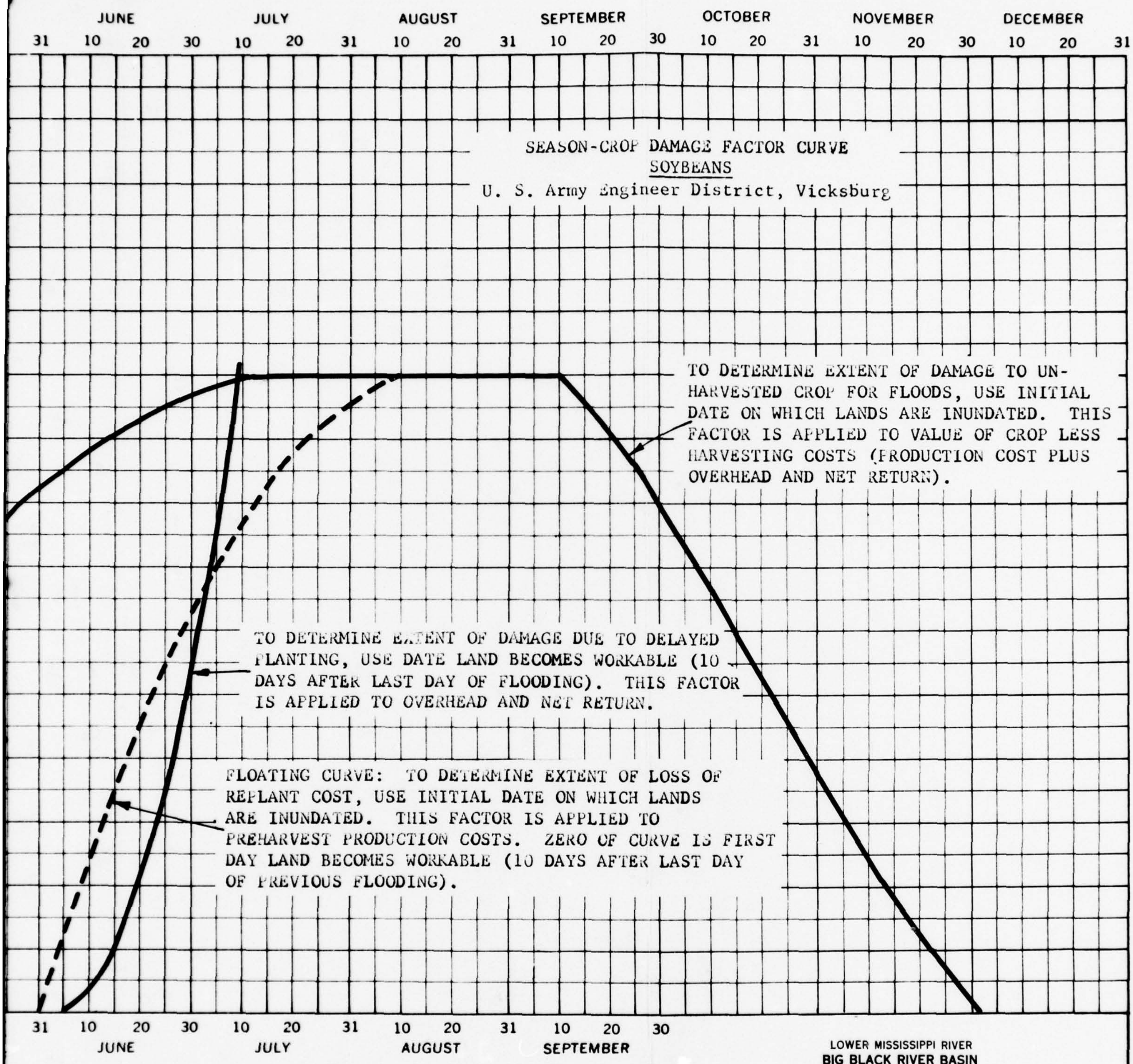


LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

SEASON - CROP DAMAGE FACTOR CURVE
SOYBEANS

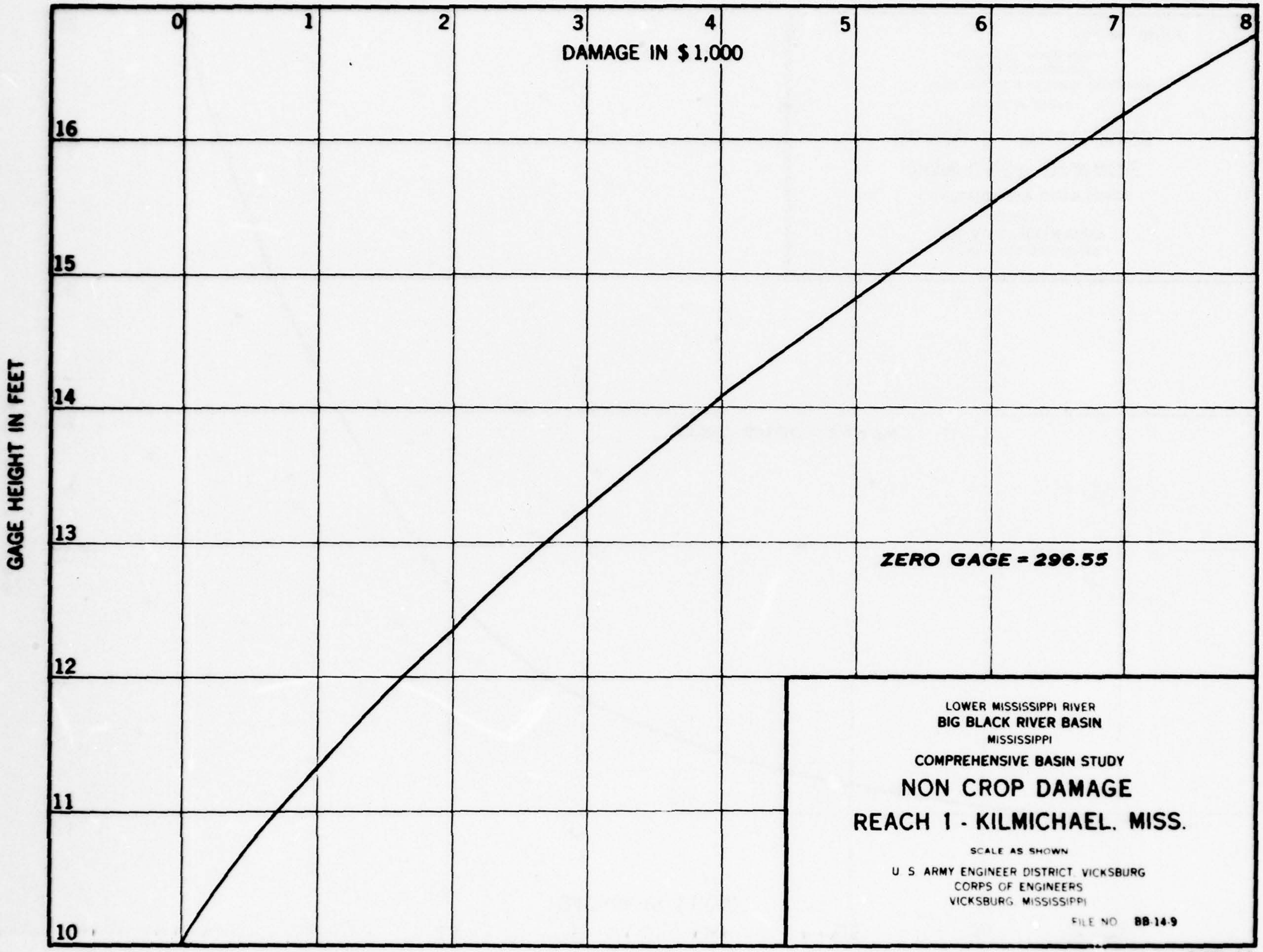
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

2

PLATE C-4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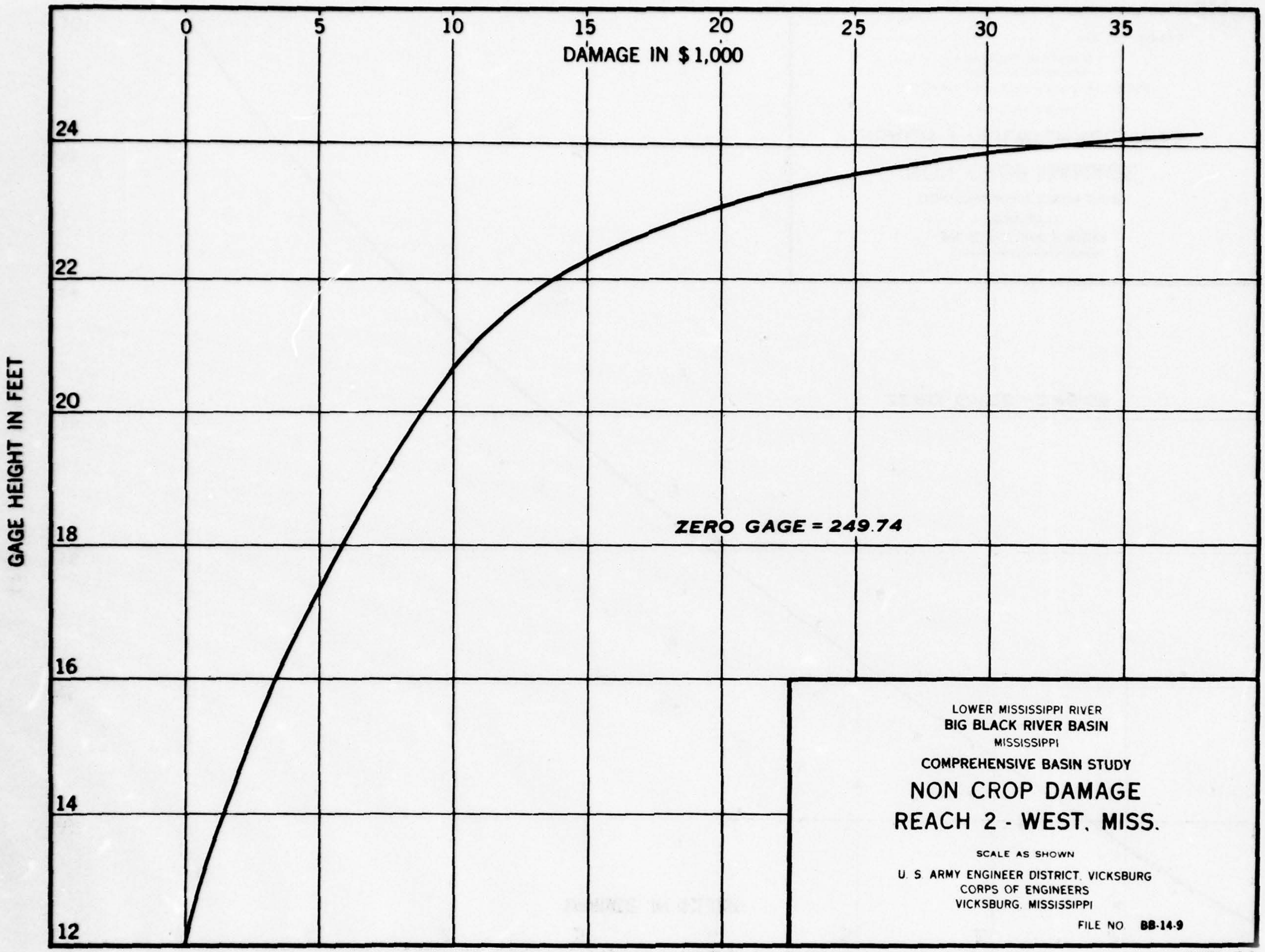
LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY
NON CROP DAMAGE
REACH 1 - KILMICHAEL, MISS.
SCALE AS SHOWN
U S ARMY ENGINEER DISTRICT VICKSBURG
CORPS OF ENGINEERS
VICKSBURG MISSISSIPPI
FILE NO BB-14-9

PLATE C-5



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI

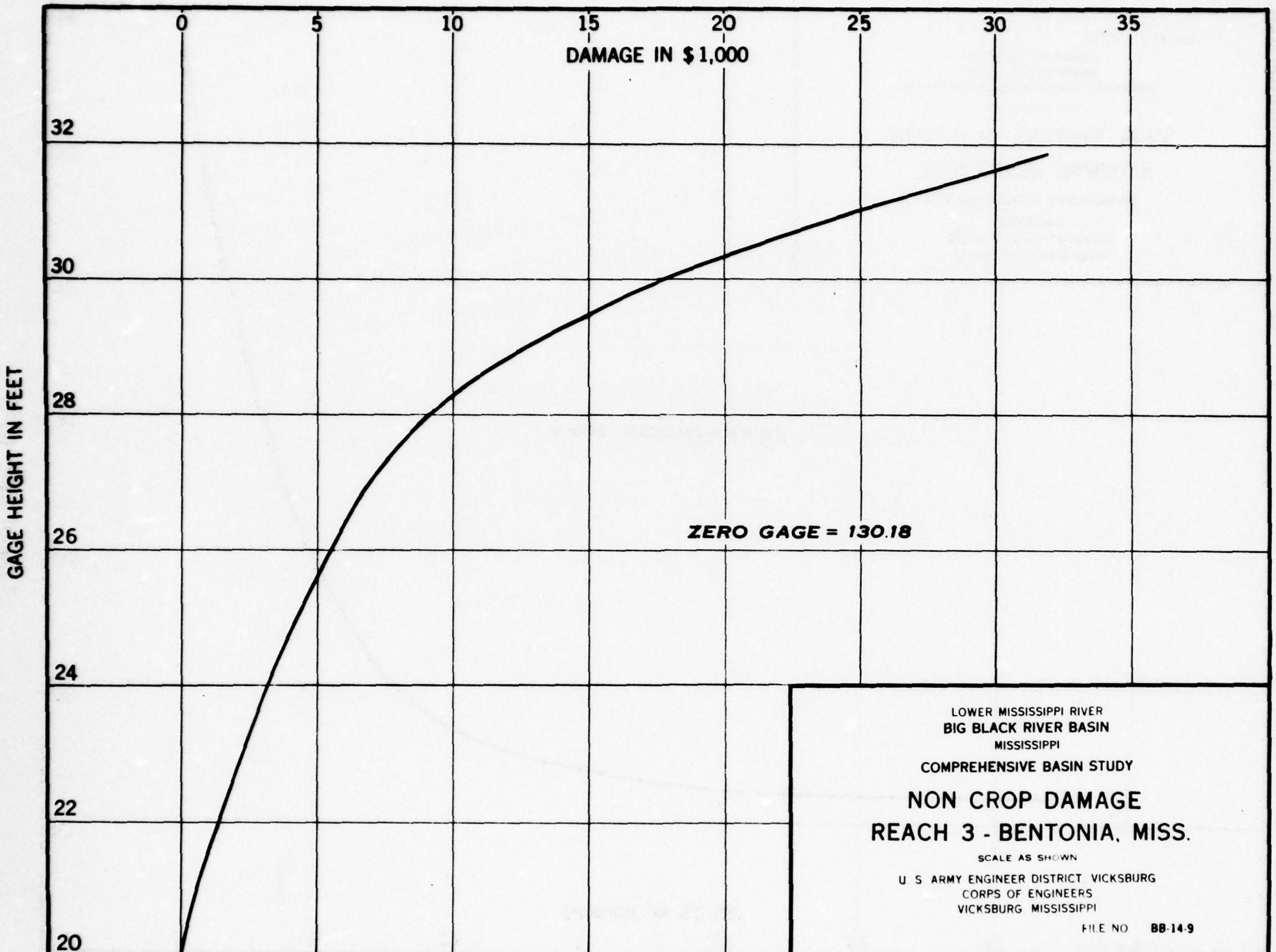
COMPREHENSIVE BASIN STUDY

NON CROP DAMAGE
REACH 2 - WEST. MISS.

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

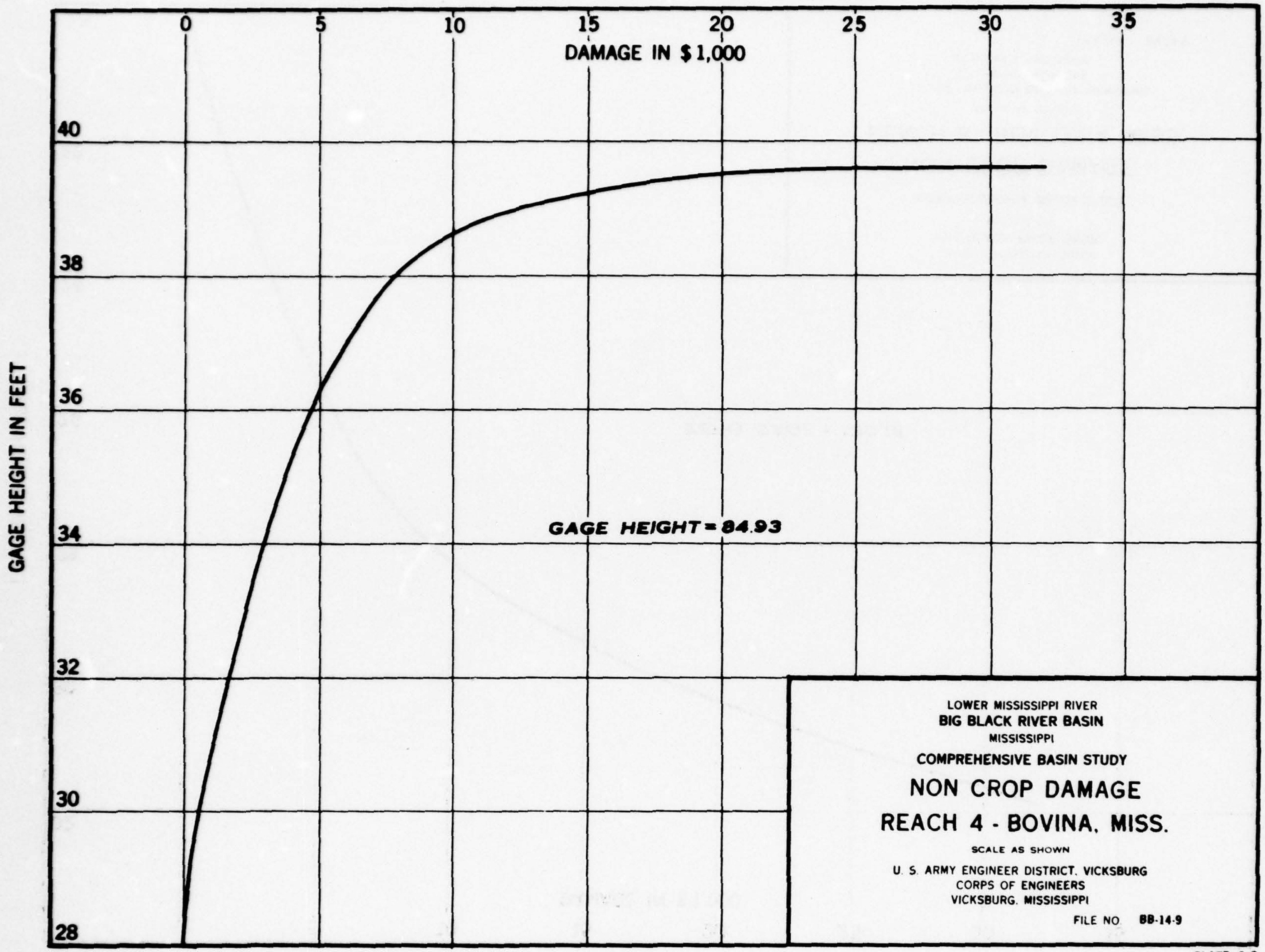
NON CROP DAMAGE
REACH 3 - BENTONIA, MISS.

SCALE AS SHOWN

U S ARMY ENGINEER DISTRICT VICKSBURG
CORPS OF ENGINEERS
VICKSBURG MISSISSIPPI

FILE NO BB-14-9

PLATE C-7



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

NON CROP DAMAGE

REACH 4 - BOVINA, MISS.

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

PLATE C-8

APPENDIX D
BIG BLACK RIVER BASIN
ECONOMIC DEVELOPMENT BENEFITS

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TABLES

APPENDIX D

BIG BLACK RIVER BASIN
ECONOMIC DEVELOPMENT BENEFITS

1. GENERAL

Any of the projects considered in this study of the Big Black River Basin would be constructed either partially or entirely in an area where the median family income is less than $2,264; and therefore is currently designated as eligible for assistance under the Public Works and Economic Development Act of 1965. Where projects are proposed for such areas, Senate Document 97, 87th Congress, provides that cognizance be taken of economic development benefits and that project benefits be increased by that amount.

2. SCOPE

This evaluation was made to estimate the economic impact of construction of the plans considered on the economy of the area in terms of economic development benefits.

3. DESIGNATED AREA

All of the counties through which the project would be constructed are currently (July 1966) designated as eligible for assistance under Public Law 89-136, the Economic Development Act of 1965, except Hinds and Warren Counties. There are 18 counties, Table D-1, in proximity to where construction would take place from which workers could expect to be recruited. There was an average of over 1,500 male registered jobseekers (applications in agricultural and domestic service occupations excluded) in those 18 counties each month during the 6-month period from July to December 1966.

4. METHODOLOGY AND ASSUMPTIONS

a. Construction of any of the projects studied would have a significant and varied impact on the economy of the area. It would create new jobs and income flows over its life which would result from, but not be limited to, the demand for labor to construct, operate, and maintain the project; and increase in demand forconstruction materials which would more fully utilize the people employed in that industry and probably require an increase in the number of employees. These factors would be a significant stimulant to the economy and raise the general level of income in the economically depressed area. Thus, it would appreciably alleviate the unemployment and underemployment of labor. Senate Document 97, 87th Congress, provides that "project benefits shall be considered as increased by the value of the labor and other resources required for project construction

TABLE D-1
COUNTIES IN PROXIMITY TO PROJECT CONSTRUCTION ELIGIBLE FOR ECONOMIC DEVELOPMENT ASSISTANCE AND NUMBER OF MALE REGISTERED JOBSEEKERS (1)

Location of State Employment Office	County	Male registered
Greenwood	Carroll, Humphreys, Leflore, Tallahatchie	304
Grenada	Grenada (3), Calhoun, Webster, Montgomery	385
Louisville	Choctaw, Winston	121
Vicksburg	Claiborne, Issaquena, Sharkey, Warren (3)	335
Yazoo City	Yazoo	84
Canton	Madison	76
Lexington	Holmes	113
Kosciusko	Attala	147
Total	18	1,565

(1) Applications in agricultural and domestic service occupations excluded. Data were reported by areas served by each office rather than by counties.
(2) Average for the 6-month period-July to December 1966.
(3) Counties presently not qualified for assistance under the Economic Development Act.

Source: Labor Market Information, Miss. State Employment Service, Jackson, Miss., January 1967.

and expected to be used in project operation, project maintenance, and added area employment during the life of the project to the extent that such labor and other resources would, in the absence of the project, be unutilized or under utilized." An attempt was made to measure the economic development benefits from both (1) the value of unemployed and underemployed labor expected to be used in project construction, operation, and maintenance, and (2) the other benefits. The method used to determine the economic development benefits from (2) above, indicated that such benefits probably would be greater than for (1). However, due to the difficulty of precisely measuring the total economic impact on the designated areas, or the total number of unemployed or underemployed people that would be more productively employed as a result of construction of the project, and to be conservative, the criteria for estimating area economic development benefits for the purposes of this report was limited to construction contract expenditure and operation and maintenance expenditure for labor that would likely come from unemployed or underemployed labor in those counties designated as eligible by the Economic Development Administration. Therefore, the criteria used result in a conservative estimate of economic development benefits and the clear inference that other economic development benefits will accrue.

b. The considered plans were analyzed with and without an allowance for economic development benefits. However, for the purposes of this report, the total allowance for these benefits was added to the total benefits of each plan and a benefit-to-cost ratio was determined. The procedures employed to derive the economic development benefits are as follows:

(1) Project construction. An analysis of onsite construction expenditures by comparing similar work completed in the area was made to estimate the proportion of construction cost that would accrue to local labor used in project construction. Those crafts that contractors ordinarily retain were not considered as likely to come from local labor even though such crafts may be available in the area. The percentage of contract expenditure for local labor as determined from the study was applied feature by feature to the estimated cost of the project. Local labor averaged 24 percent of the total cost. It was assumed that 75 percent of local labor would come from the unemployed or underemployed ranks. This assumption seems reasonable in view of the number of unemployed workers in the area.

(2) Project operation and maintenance. Labor was estimated to be 90 percent of the ordinary maintenance for the channel excavation and local protection plans with all labor assumed to come from the local unemployed and underemployed. For the tributary reservoirs and main stem reservoir, 70 percent of the maintenance cost is expected to be labor from local unemployed or underemployed. Local labor was estimated to be 100 percent of the recreation facility operation and maintenance cost. The allowance for operation and maintenance expenditure

was further reduced to reflect the local labor that will come from counties eligible for economic development assistance. These costs were modified to reflect decreasing values over an assumed 10-year period of economic recovery and converted to average annual cost.

5. ECONOMIC DEVELOPMENT BENEFITS

Based on the procedure outlined above, the estimated project first cost and allowance for economic development benefits are shown in Table D-2. The estimated annual operation and maintenance cost and average annual allowance for economic development benefits are shown in Table D-3. The allowance on annual operation and maintenance reflects decreasing values over an assumed 10-year period of economic recovery converted to average annual cost. The total average annual economic development benefit was estimated by converting the allowance for these benefits accruing to first cost to an average annual benefit and adding this to the average annual allowance for economic development benefits attributable to operation and maintenance.

APPENDIX D

TABLE D-2

ESTIMATED PROJECT COSTS AND ECONOMIC DEVELOPMENT BENEFITS

Item	Edwards main stem reservoir		Tributary reservoirs		Main stem channel improvement 3 yr. freq.		Main stem channel improvement 1-yr. freq.		Local protection projects			
									Goodman loop levee		Apookta loop levee	
	Estimated first cost	Allowance for economic development benefits	Estimated first cost	Allowance for economic development benefits	Estimated first cost	Allowance for economic development benefits	Estimated first cost	Allowance for economic development benefits	Estimated first cost	Allowance for economic development benefits	Estimated first cost	Allowance for economic development benefits
	$	$	$	$	$	$	$	$	$	$	$	$
Lands	17,210,000	-	11,100,000	-	3,340,000	-	2,480,000	-	55,000	-	44,000	-
Dams	13,600,000	1,792,000	10,520,000	1,381,000	-	-	-	-	-	-	-	-
Power plant	10,100,000	398,000	-	-	-	-	-	-	-	-	-	-
Channels	-	-	-	-	37,420,000	6,020,000	14,850,000	2,406,000	76,000	14,000	50,000	8,800
Levee	-	-	-	-	-	-	-	-	434,000	51,000	306,000	40,000
Drainage structure	-	-	-	-	-	-	-	-	245,000	46,000	240,000	44,000
Relocations	32,610,000	5,136,000	4,100,000	646,000	13,050,000	2,054,000	8,990,000	1,416,000	9,000	1,500	-	-
Recreation facilities	7,401,000	1,943,000	2,780,000	729,000	-	-	-	-	-	-	-	-
Engineering and design	6,370,000	-	1,740,000	-	3,630,000	-	1,730,000	-	57,000	-	48,000	-
Supervision and administration	5,600,000	-	1,530,000	-	3,130,000	-	1,570,000	-	61,000	-	48,000	-
Total	92,890,000	9,269,000	31,770,000	2,756,000	60,570,000	8,074,000	29,620,000	3,822,000	937,000	112,500	736,000	92,800
Annual economic development benefits (not including O&M)	314,000		93,000		329,000		156,000		4,600		3,800	

TABLE D-3

ANNUAL OPERATIONS AND MAINTENANCE COST AND ALLOWANCE FOR ECONOMIC DEVELOPMENT BENEFITS

Item	Edwards main stem reservoir	Tributary reservoirs	Main stem channel improvement 3-yr. freq.	Main stem channel improvement 1-yr. freq.	Local Protection Projects: Goodman Loop Levee	Local Protection Projects: Apookta Loop Levee
	$	$	$	$	$	$
Total annual operation and maintenance cost	1,043,000	245,000	126,000	126,000	2,200	2,000
Payments for local unemployed labor	885,000	195,000	96,000	96,000	1,700	1,600
Present value of decreasing annuity for 10 years (48.54169)	4,296,000	951,000	468,000	468,000	8,400	8,100
Average annual O&M value at 3-1/4 percent	146,000	32,000	19,000	19,000	400	300

APPENDIX E
BIG BLACK RIVER BASIN
GENERAL RECREATION

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APPENDIX E
BIG BLACK RIVER BASIN
GENERAL RECREATION

1. GENERAL

This appendix gives the procedure followed in satisfying the requirement of the Federal Water Projects Recreation Act of 9 July 1965 that full consideration be given to opportunities for inclusion of outdoor recreation enhancement at certain Federal water development projects. It presents the methods used to determine recreation supply, demand, and needs within the study area; the recreation capacity and required facilities for the Corps of Engineers reservoirs; and the value of this recreation potential.

2. METHODOLOGY

a. Recreation market area. In this report it was assumed that all of the use of the recreation facilities at the Corps of Engineers reservoirs within the Big Black River Basin would be drawn from the recreation market area. The recreation market area for the Big Black River Basin consists of the ten Mississippi counties and the western portion of Hinds County which make up the study area plus an additional 30 percent of the population of the Jackson, Mississippi, Standard Metropolitan Statistical Area (SMSA). The recreation market area for the tributary reservoirs is divided into two subareas referred to in this appendix as Reach A and Reach B. The northernmost area, Reach A, is made up of Attala, Carroll, Choctaw, Holmes, Montgomery, and Webster Counties plus 12 percent of the Jackson SMSA. Reach B consists of Claiborne, Hinds (west portion only), Madison, Warren, and Yazoo Counties and 18 percent of the Jackson SMSA.

b. Demand.

(1) The Bureau of Outdoor Recreation has developed methods of computing recreation demand specifically for the Southeast Region. The Outdoor Recreation Resources Review Commission (ORRRC) Study Report 19 indicates that the residents of different regions of the country participate in various outdoor activities at rather consistent rates. For example, the study found that people in the South (12 years of age and older) engaged in swimming on an average of 5.54 times each year. Similar participation rates were determined for the other forms of outdoor recreation. The ORRRC study also found that recreational activity rates varied directly with personal income. It, therefore, follows that any recreation demand estimate should consider per capita income as well as polulation.

(2) The Bureau of Outdoor Recreation developed a set of factors for deriving average summer Sunday and total annual recreational demand estimates for the Big Black River Basin study area. These factors are based on the participation rates of the ORRRC study with adjustments for the population and per capita income of the study area. The factors developed by BOR were used in computing the demand estimates expressed as activity occasions for outdoor recreation in the recreation market area. An activity occasion is defined as the participation by one person in one activity during any part of one day. The activities considered were swimming, boating, camping, and picnicking plus "other activities" which include incidental fishing, hiking, and nature walks. Incidental fishing, as used here, is the fishing occurring in connection with camping, picnicking, or similar recreational activity. It does not include the serious fisherman whose primary motivation for outdoor recreation on a particular day is fishing. Although there are demands for other forms of outdoor recreation in the study area, it is believed that those considered would make up the principal recreational use of the reservoirs.

(3) An example of the use of these factors for computing the demand for swimming within the Big Black River Basin recreation market area in 1980 is as follows:

AVERAGE SUMMER SUNDAY DEMAND FOR
SWIMMING IN RECREATION MARKET AREA (1980)

Market area segment	Population	Swimming factor	Demand in activity occasions
Big Black Basin			
Reach A	76,700	0.1184	9,081
Reach B	171,800	0.1184	20,341
Jackson SMSA			
Reach A	40,200	0.1910	7,678
Reach B	60,400	0.1910	11,536
Total activity occasions			48,636

TOTAL ANNUAL DEMAND FOR
SWIMMING IN RECREATION MARKET AREA (1980)

Market area segment	Population	Swimming factor	Demand in activity occasions
Big Black Basin			
Reach A	76,700	5.373	412,109
Reach B	171,800	5.373	923,081
Jackson SMSA			
Reach A	40,200	8.666	348,373
Reach B	68,400	8.666	523,426
Total for Recreation Market Area			2,206,989

(4) The average summer Sunday demand and the total annual demand estimates for the years 1980 and 2015 for all recreational activities considered are given in Tables E-1 and E-2.

c. Conversions to recreation days. A recreation day is a standard unit of use consisting of a visit by one individual to an outdoor recreation development or area for recreation purposes during any reasonable portion or all of a 24-hour day. The average participant in outdoor recreation engages in more than one activity during a recreation day. For example, picnicking might be combined with boating or hiking with camping. In its evaluation of outdoor recreation in the Big Black River Basin, the Bureau of Outdoor Recreation used a factor of 2.3 activity occasions per recreation day. In view of the fact that sightseeing was not included by the Corps of Engineers as a potential recreational activity for the reservoir sites studied, the Bureau of Outdoor Recreation suggested that a recreation day on the Corps of Engineer reservoirs in the Big Black Basin should consist of 1.9 activity occasions. The Vicksburg District agrees that this is a reasonable figure based on the variety and type of recreation activities that would be offered at the reservoirs. Conversions to recreation days are made by dividing the total of activity occasions by 1.9.

d. Recreation supply and needs. Data on the existing and future recreational supply within the recreation market area was furnished by the Bureau of Outdoor Recreation. The information regarding public facilities came primarily from the Bureau's nationwide inventory forms and the private supply data from the Mississippi Inventory of Outdoor Recreation for 1965 prepared by the National Association of Conservation Districts. Supply and needs data for the years 1980 and 2015 are shown in Tables E-1 and E-2.

e. Estimates of project-induced recreation on Corps of Engineers reservoirs.

(1) Tributary reservoirs. The recreational capacity was computed for the nine reservoirs in Reach A totaling 7,320 surface acres and the eight reservoirs in Reach B totaling 6,490 acres. The method of computation and the reservoir "mix" formulas and factors used are those presently in use by the Bureau of Outdoor Recreation. The mix factor for the "other activities" group differs from that used by the BOR in their appendix because of the omission of sightseeing from this group in the Corps of Engineer's reservoir evaluation. This "mix" was developed by using boating as the basic activity on a reservoir since boating is definitely limited by the size of the body of water. After determining a boating factor, the factors for all other activities were then determined by relating them to the boating factor in the same proportion as the ORRRC participation rates for these activities in the Census South. The use of these factors is demonstrated

APPENDIX E

TABLE E-1

BIG BLACK RIVER BASIN STUDY AREA
RECREATION DEMAND, SUPPLY AND NEEDS
ACTIVITY OCCASIONS (EXCEPT AS LABELED)

REACH A

1980	Swimming	Boating	Picnicking	Camping
Average summer Sunday demand	16,800	5,200	5,500	2,800
Daily supply capacity	5,100	700	3,300	1,100
Daily unsatisfied demand	11,700	4,500	2,200	1,700
Need in facilities	19 acres beach	9,058 acres	220 tables	350 units
Total annual demand	760,500	334,900	380,200	108,600
Annual use from supply	231,800	43,300	231,000	38,500
*Annual unsatisfied demand	528,700	291,600	149,200	70,100

*An additional total annual demand of 853,100 activity occasions exists for "other" activities which includes incidental fishing, hiking and nature walks.

REACH B

1980	Swimming	Boating	Picnicking	Camping
Average summer Sunday demand	31,900	9,900	10,500	5,400
Daily supply capacity	4,000	1,800	2,000	500
Daily unsatisfied demand	27,900	8,100	8,500	4,900
Need in facilities	46 acres	16,100 acres	850 tables	980 units
Total annual demand	1,446,500	637,000	723,200	206,500
Annual use from supply	181,900	119,900	141,000	16,300
**Annual unsatisfied demand	1,264,600	517,100	582,100	190,200

**An additional total annual demand of 1,622,600 activity occasions exists for "other" activities which includes incidental fishing, hiking and nature walks.

APPENDIX E

TABLE E-2

BIG BLACK RIVER BASIN STUDY AREA
RECREATION DEMAND, SUPPLY AND NEEDS
ACTIVITY OCCASIONS (EXCEPT AS LABELED)

REACH A

2015	Swimming	Boating	Picnicking	Camping
Average summer Sunday demand	47,300	14,700	15,600	8,000
Daily supply capacity	5,100	700	3,300	1,100
Daily unsatisfied demand	42,200	14,000	12,300	6,900
Need in facilities	70 acres beach	28,000	1,230 tables	1,380 units
Total annual demand	2,146,100	945,100	1,073,100	306,300
Annual use from supply	231,800	43,300	231,000	38,500
*Annual unsatisfied demand	1,914,300	901,800	842,100	267,800

*An additional total annual demand of 2,407,500 activity occasions exists for "other" activities which includes incidental fishing, hiking, and nature walks.

REACH B

2015	Swimming	Boating	Picnicking	Camping
Average summer Sunday demand	110,000	34,100	36,400	18,500
Daily supply capacity	4,000	1,800	2,000	500
Daily unsatisfied demand	106,000	32,300	34,400	18,000
Need in facilities	177 acres beach	64,600 acres	3,440 tables	3,600 units
Total annual demand	4,993,800	2,199,200	2,497,000	712,800
Annual use from supply	181,900	119,900	141,100	16,300
**Annual unsatisfied demand	4,811,900	2,079,300	2,355,900	696,500

**An additional total annual demand of 5,602,100 activity occasions exists for "other" activities which includes incidental fishing, hiking and nature walks.

in the computation of the recreational capacity of the tributary reservoirs (Table E-3). Because of the large unsatisfied demand in the recreation market area, it is estimated that the tributary reservoirs in both reaches would attract fifty percent of their annual recreation capacity the first year after completion. Since the recreation demand would far exceed the capacity of the reservoirs plus the existing supply in Reach B, it is estimated that the reservoirs in this reach would attract full capacity three years after completion. Recreation demand in Reach A would not exceed the supply before 1990 and it is estimated that the reservoirs in Reach A would draw full recreational capacity in that year. These estimates result in the following recreational use of the reservoirs:

REACH A

Item	Years 1980	1990	2030
Recreation days	657,000	1,313,000	1,313,000

REACH B

Item	1980	1983	2030
Recreation days	582,000	1,164,000	1,164,000

(2) Edwards Reservoir. The recreational capacity of the 43,000 acre Edwards Reservoir was computed by the use of the same "mix" formulas as previously described. The demand for the recreation opportunity that would be offered by the Edwards Reservoir was assumed to originate within the recreation market area consisting of the counties of Reach B plus 30 percent of the Jackson SMSA. The capacity of the Edwards Reservoir would exceed the recreation need in the recreation market area in 1980. It would, however, be unrealistic to expect all of this need for water-oriented recreation to concentrate at this one location. It was assumed that only one-half of the need would be satisfied at the reservoir in 1980 and that full recreational capacity for the reservoir would be attained in 2030. By the latter year, the need in the recreation market area is expected to greatly exceed the capacity of the reservoir. The resulting estimate of recreational use of the Edwards Reservoir is as follows:

Item	Years 1980	2030	2080
Recreation days	1,500,000	7,700,000	7,700,000

APPENDIX E

TABLE E-3

RECREATION CAPACITY OF CORPS OF ENGINEERS TRIBUTARY RESERVOIRS

REACH A (7,320 surface acres)					
Item	Swimming	Boating	Picnicking	Camping	Other
Average summer Sunday (activity occasions)	22,500	3,700	7,400	2,100	5,300
Annual activity occasions	1,018,000	237,900	511,200	76,700	651,300

Total annual activity occasions = 2,495,000
Total annual recreation days = 1,313,000

REACH B (6,490 surface acres)					
Item	Swimming	Boating	Picnicking	Camping	Other
Average summer Sunday (activity occasions)	20,000	3,200	6,600	1,900	4,700
Annual activity occasions	902,300	210,900	453,300	68,000	577,500

Total annual activity occasions = 2,212,000
Total annual recreation days = 1,164,000

Reservoir surface acres x daily use factor = daily capacity in activity occasions

Swimming = 3.08
Boating = 0.50
Picnicking = 1.01
Camping = 0.29
Other activities = 0.73

Daily capacity x annual use factor = annual capacity in activity occasions

Swimming = 45.14
Boating = 65.00
Picnicking = 69.15
Camping = 36.11
Other activities = 121.88

$$\frac{\text{Annual capacity in activity occasions}}{1.9} = \text{annual capacity in recreation days}$$

f. Recreation day value. The Bureau of Outdoor Recreation suggested a value of 75 cents per recreation day for the Corps of Engineers tributary reservoirs. The Vicksburg District agrees that this is a reasonable evaluation based on the criteria outlined in Senate Document No. 97, Supplement No. 1. The reservoirs would offer swimming beaches, camping and picnic grounds with sanitary facilities, parking spaces, water supply and convenient access to the water. For the Edwards Reservoir, however, a recreation day was valued at $1.25. The lower value of 75 cents assessed here for a recreation day on the tributary reservoirs as opposed to the $1.25 recreation day value for the Edwards Reservoir results from the differences in locations and in basic physical and aesthetic characteristics. The tributary reservoirs would not be readily accessible to large urban populations and would have relatively small surface areas. The Edwards Reservoir would be within 30 miles of the urban population of Jackson and within 25 miles of Vicksburg.

g. Recreation benefits.

(1) The estimated number of recreation days that would be induced annually by the tributary reservoirs was multiplied by $0.75 to obtain the general recreation benefit. The results are as follows:

TRIBUTARY RESERVOIRS

REACH A

Item	Years 1980	1990	2030
Recreation day	657,000	1,313,000	1,313,000
Value (x 0.75)$	493,000	985,000	985,000
Average annual benefit (3 1/4% interest) $			918,000

REACH B

Item	1980	1983	2030
Recreation days	582,000	1,164,000	1,164,000
Benefit (x 0.75) $	437,000	873,000	873,000
Average annual benefit (3 1/4 % interest) $			859,000
Total average annual benefit, tributary reservoirs $			1,777,000

(2) For the Edwards Reservoir the general recreation benefit was obtained by multiplying the annual total of recreation days at the reservoir by $1.25 with the following results:

Item	Years 1980	2030	2080
Recreation days	1,500,000	7,700,000	7,700,000
Benefit (x 1.25) $	1,875,000	9,600,000	9,600,000
Average annual benefit (3 1/4% interest) $			5,630,000

h. Required recreation facilities. To provide for the recreational use expected at the reservoirs, adequate recreational facilities were included. The design capacity of the facilities will meet the requirements of an average summer Sunday. In determining the amount and type of facilities, the criteria contained in ER 1130-2-312 "Project Operations Facilities Criteria for Design and Construction, Civil Works Projects," and criteria presently in use by BOR were followed. Even though the tributary reservoirs would not be expected to attain full recreational capacity for the first year after completion, recreation facilities were planned for full capacity in 1980. With the large unsatisfied demand for outdoor recreation existing in the Big Black River Basin recreation market area, an excess supply of facilities in the first few years of project life would be preferable to the possibility of a deficit. Recreation facilities for the Edwards Reservoir were designed to accommodate the projected recreation load in 1980. Although full recreation capacity is expected to be reached in 2030, the completion of the facilities to meet the capacity load was planned for 2025. The recreational facility needs are shown in Tables E-4 and E-5.

i. Recreation lands. A minimum of 600 acres would be required for the placement of recreation facilities at the tributary reservoirs. An additional 600 acres would be needed to provide a buffer zone between the recreation areas and nonpublic lands. It was assumed that project lands for the Edwards Reservoir would provide ample area for recreational development.

APPENDIX E

TABLE E-4

SUMMARY OF RECREATION FACILITIES NEEDED FOR
PROJECT-INDUCED RECREATION AT THE TRIBUTARY RESERVOIRS

1980

Type facility	Units needed	
	Reach A	Reach B
Swimming beach (acres)	38	33
Launching lands	33	31
Picnic units	740	660
Camping units	420	380
Comfort stations	15	11
Water systems	15	11
Parking area (1,000 sq. ft.)	910	810
Roads (1,000 lineal ft.)	66	88

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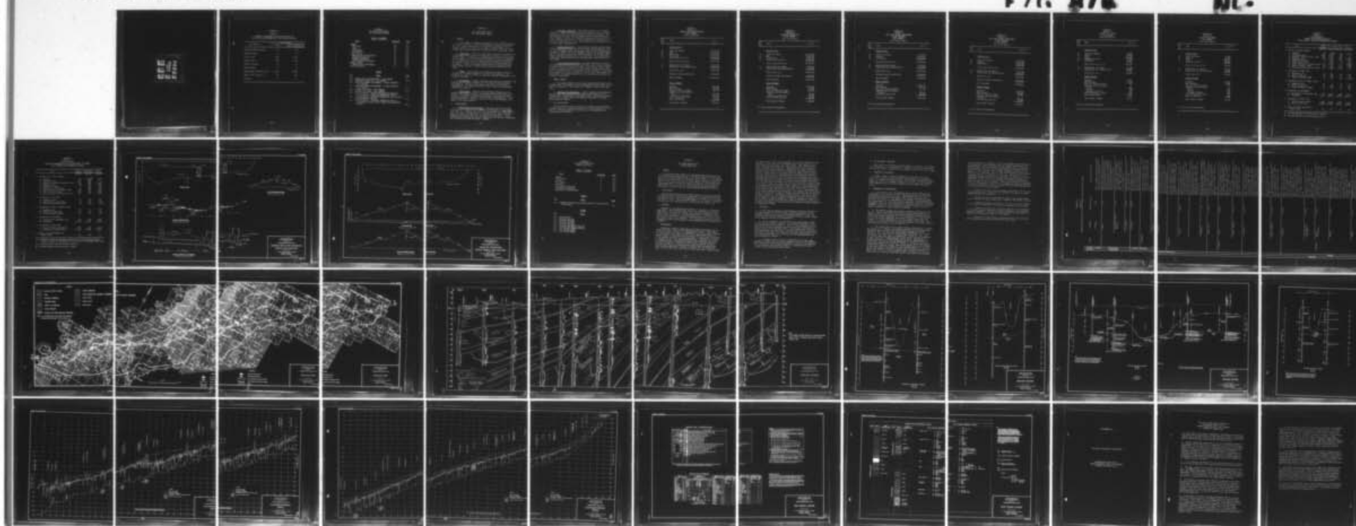

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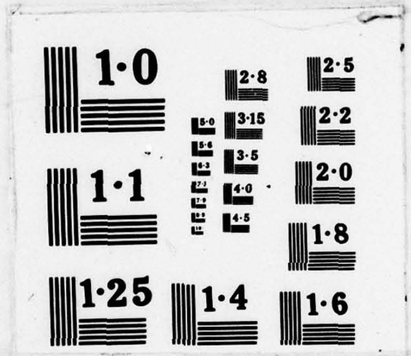
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APPENDIX E

TABLE E-5

SUMMARY OF RECREATION FACILITIES NEEDED FOR
PROJECT-INDUCED RECREATION AT THE EDWARDS RESERVOIR

Type facility	Units needed	
	1980	To be constructed between 1980 and 2025
Swimming beaches (acres)	40	180
Launching lanes	50	150
Picnic units	1,200	5,800
Camping units	800	1,700
Comfort stations	22	50
Water systems	22	50
Parking area (1,000 sq. ft.)	2,232	10,000
Roads (1,000 lineal ft.)	238	264
Overlook	1	0

APPENDIX F
BIG BLACK RIVER BASIN
COST AND ANNUAL CHARGES

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TABLES

APPENDIX F

BIG BLACK RIVER BASIN
COST AND ANNUAL CHARGES

1. GENERAL

a. This appendix contains evaluations of four different types of improvement as follows: tributary reservoirs, a main stem reservoir, main stem channel improvement, and localized loop levees. This appendix presents the costs of all plans in summary form only, since no plans are being recommended for construction at the present time.

b. Unit costs. Unit costs were based on records of similar work in the general area modified to conditions expected to exist in the immediate area. An allowance of approximately 20 percent is provided for contingencies to cover factors which are not fully investigated, and the aspects of which may change if more detailed investigations were made at a later date in the formulation of definite plans for the project. Values of engineering and design and supervision and administration conform to current directives for estimating those items.

c. Lands. A gross real estate appraisal was made, using contour maps of the area supplemented by field investigations. The estimates are based on a study of sales and a general knowledge of land values in the areas.

d. Relocations. Highway, railroad, and utilities relocations were determined by studies of channel cross sections and limited field investigation. Estimates were made on the basis of alteration or replacement of the existing facilities with a facility of equivalent standard and capacity.

e. Construction. Hydraulic and structural designs and soils analysis are adequate to allow for possible adverse construction conditions. The design of channels and hydraulic structures included hydrologic analysis, hydraulic, and structural considerations. These studies were made in sufficient detail to insure that adequate estimates of cost were obtained.

2. PLANS STUDIED

a. Edwards main stem reservoir. This plan consists of a main stem reservoir located north of Edwards, Mississippi, at approximate river mile 77. A dam at this site could pool water up to approximately mile 140. This structure would be an earthfill dam with a concrete gravity spillway (see Plate F-1 for profile and sections). It was evaluated as a multipurpose project combining flood control, recreation, and hydroelectric power as project purposes.

b. Tributary reservoirs. This plan consists of 17 tributary reservoirs. These structures, all located near the mouth of major tributary streams, are earthfill dams with sluiceway outlets. They are primarily for flood control purposes with a conservation pool which would be utilized for recreational purposes (see Plate F-2 for typical profile and sections). Each reservoir has storage for 10 inches of runoff and, as a unit, they would control 28 percent of the Big Black River drainage area.

c. Channel improvement. Two plans were studied for main stem channel improvement alone. The first channel was designed to contain the 3-year frequency storm within banks, and the other channel was designed to contain the 1-year frequency storm. The channel improvement in both plans consists of channel excavation of the main stem channel from approximately mile 11 to mile 263. All work consists of trapezoidal channel sections with varying bottom widths and 1 on 3 side slopes.

d. Local protection projects. This plan involved a series of loop levees along the main stem of the river. These levees, ranging in height from 17 to 20 feet and from 4 to 9 miles in length, would parallel the general course of the river and tie into the hill line. Interior drainage would be discharged through floodgates in the levees. Cost estimates are shown for only 2 of the 17 sites investigated, as preliminary investigation showed that the remaining sites would lack economic justification.

3. ANNUAL CHARGES

a. The annual charges for the plans considered are based on an economic life of 50 years for channel improvements and levees, and 100 years for reservoirs. The current 3-1/4 percent interest rate was used.

b. Operation and maintenance. Annual operation and maintenance costs for the plans considered are based on experienced cost of similar works in operation in the general area. These costs normally include cost of labor, plant, and supplies required for ordinary maintenance and repairs.

4. COST ALLOCATIONS

The allocation of cost to each project purpose for the Edwards reservoir and the 17 tributary reservoirs is shown on Tables F-7, F-8, and F-9. These allocations were made using the separable costs remaining benefits method.

APPENDIX F
TABLE F-1
EDWARDS MAIN STEM RESERVOIR
COST SUMMARY
(1967 Price Level)

Cost Acct No	Item	Cost
		$
	Initial costs	
01	Lands and damages	17,210,000
04	Dams	13,600,000
07	Power plant	10,100,000
02	Relocations	32,610,000
14	Recreation facilities	7,400,000
	Total construction cost	80,920,000
30	Engineering and design	6,370,000
31	Supervision and administration	5,600,000
	Total first cost	92,890,000
	Interest during construction	7,550,000
	Net investment	100,440,000
	Annual charges	
	Interest	3,264,000
	Amortization	139,000
	Loss net return on lands	284,000
	Operation and maintenance:	
	Dams	200,000
	Recreation facilities	843,000
	Fish and wildlife loss	69,000
	Major replacement	30,000
	Total annual charges	4,829,000

APPENDIX F
TABLE F-2
TRIBUTARY RESERVOIRS
COST SUMMARY
(1967 Price Level)

Cost Acct No	Item	Cost 1/
	Initial costs	
01	Lands and damages	11,100,000
04	Dams	10,520,000
02	Relocations	4,100,000
14	Recreation facilities	2,780,000
	Total construction cost	28,500,000
30	Engineering and design	1,740,000
31	Supervision and administration	1,530,000
	Total first cost	31,770,000
	Interest during construction	1,550,000
	Net investment	33,320,000
	Annual charges	
	Interest	1,083,000
	Amortization	46,000
	Loss net return on lands	185,000
	Operation and maintenance:	
	Dams	95,000
	Recreation facilities	150,000
	Fish and wildlife loss	36,000
	Total annual charges	1,595,000

1/ Costs include contingencies

APPENDIX F
TABLE F-3
MAIN STEM CHANNEL IMPROVEMENT
3-YEAR FREQUENCY
COST SUMMARY
(1967 Price Level)

Cost Acct No	Item	Cost [1/]
	Initial costs	
01	Lands and damages	3,340,000
09	Channels	37,420,000
02	Relocations	13,050,000
	Total construction cost	53,810,000
30	Engineering and design	3,630,000
31	Supervision and administration	3,130,000
	Total first cost	60,570,000
	Interest during construction	2,950,000
	Net investment	63,520,000
	Annual charges	
	Interest	2,064,000
	Amortization	523,000
	Loss net return on lands	48,000
	Operation and maintenance:	
	Channels	200,000
	Fish and wildlife loss	139,000
	Total annual charges	2,974,000

[1/] Costs include contingencies

APPENDIX F

TABLE F-4

MAIN STEM CHANNEL IMPROVEMENT

1-YEAR FREQUENCY

COST SUMMARY

(1967 Price Level)

Cost Acct No	Item	Cost [1/]
	Initial costs	
01	Lands and damages	2,480,000
09	Channels	14,850,000
02	Relocations	8,990,000
	Total construction cost	26,320,000
30	Engineering and design	1,730,000
31	Supervision and administration	1,570,000
	Total first cost	29,620,000
	Interest during construction	1,440,000
	Net investment	31,060,000
	Annual charges	
	Interest	1,010,000
	Amortization	256,000
	Loss net return on lands	33,000
	Operation and maintenance:	
	Channels	200,000
	Fish and wildlife loss	55,000
	Total annual charges	1,554,000

1/ Costs include contingencies

APPENDIX F
TABLE F-5
GOODMAN LOOP LEVEE
COST SUMMARY
(1967 Price Level)

Cost Acct No	Item	Cost 1/
	Initial costs	
01	Lands and damages	55,000
09	Channels	76,000
11	Levee	434,000
15	Drainage structure	245,000
02	Relocations	9,000
	Total construction cost	764,000
30	Engineering and design	57,000
31	Supervision and administration	61,000
	Total first cost	937,000
	Annual charges	
	Interest	30,500
	Amortization	7,700
	Loss net return on lands	700
	Operation and maintenance:	
	Levees	1,000
	Ditches	800
	Drainage structure	500
	Fish and wildlife losses	1,000
	Major replacements	200
	Total annual charges	42,400

1/ Costs include contingencies.

APPENDIX F
TABLE F-6
APOOKTA LOOP LEVEE
COST SUMMARY
(1967 Price Level)

Cost Acct No	Item	Cost [1/]
	Initial costs	
01	Lands and damages	44,000
09	Channels	50,000
11	Levee	306,000
15	Drainage structure	240,000
	Total construction cost	640,000
30	Engineering and design	48,000
31	Supervision and administration	48,000
	Total first cost	736,000
	Annual charges	
	Interest	23,900
	Amortization	6,100
	Loss net return on lands	600
	Operation and maintenance:	
	Levees	700
	Ditches	800
	Drainage structure	500
	Fish and wildlife losses	400
	Major replacements	200
	Total annual charges	33,200

[1/] Costs include contingencies.

APPENDIX F
TABLE F-7
COST ALLOCATION
EDWARDS MULTIPURPOSE RESERVOIR
FLOOD CONTROL, POWER, AND RECREATION PROJECT

Item	Flood control	Recreation	Power	Total
	($1,000)	($1,000)	($1,000)	($1,000)
1. Alloc. of annual charges				
a. Benefits	285	5,988 1/	709	6,982
b. Alternate costs	2,525	1,814	360	-
c. Benefits limited by alt. costs	285	1,814	360	2,459
d. Separable cost	571	1,166	1,116	2,853
e. Remaining benefits	0	648	0	648
f. Alloc. joint costs	0	1,981	0	1,981
g. Total allocation, economic costs	571	3,147	1,116	4,834 2/
h. Loss of return, lands	61	162	61	284
i. Total allocation, project costs	510	2,985	1,055	4,550
2. Allocation of OM&R costs				
a. Separable cost	30	843	159	1,032
b. Alloc. joint cost	0	114	0	114
c. Total allocation, OM&R	30	957	159	1,146 2/
3. Allocation, loss of return, lands				
a. Separable cost	61	0	61	122
b. Alloc. joint cost	0	162	0	162
c. Total allocation, lands	61	162	61	284
4. Allocation of investment				
a. Allocation of investment cost	480	2,028	896	3,404
b. Investment	14,163	59,867	26,418	100,448
5. Allocation of first cost				
a. Interest during const.	1,064	4,499	1,985	7,548
b. Alloc. first cost	13,099	55,368	24,433	92,900
6. Ratio of annual benefits to annual costs	0.5	1.9	0.6	1.4

1/ Includes $185,000 fish and wildlife benefits.

2/ Includes $69,000 fish and wildlife losses.

APPENDIX F
TABLE F-8
COST ALLOCATION
TRIBUTARY RESERVOIRS
FLOOD CONTROL AND RECREATION PROJECT

Item	Flood control ($1,000)	Recreation ($1,000)	Total ($1,000)
1. Allocation of annual charges			
a. Benefits	552	1,912 1/	2,464
b. Alternate costs	1,327	687	-
c. Benefits limited by alternate costs	552	687	1,239
d. Separable cost	908	268	1,176
e. Remaining benefits	0	419	419
f. Allocation joint costs	0	419	419
g. Total allocation, economic costs	908	687	1,595
h. Loss of return, lands	124	61	185
i. Total allocation, project costs	784	626	1,410
2. Allocation of O&M costs			
a. Separable costs	68	150	218
b. Allocation joint costs	0	63	63
c. Total allocation of O&M costs	68	213	281 2/
3. Allocation of loss of return, lands			
a. Separable cost	124	0	124
b. Allocation of joint cost	0	61	61
c. Total allocation, lands	124	61	185
4. Allocation of investment			
a. Allocation of investment cost	716	413	1,129
b. Investment	21,125	12,195	33,320
5. Allocation of first cost			
a. Interest during construction	983	567	1,550
b. Allocation of first costs	20,142	11,628	31,770
6. Ratio of annual benefits to annual costs	0.6	2.8	1.5

1/ Includes $45,000 fish and wildlife benefits.

2/ Includes $36,000 fish and wildlife losses.

APPENDIX F
TABLE F-9
COST ALLOCATION
TRIBUTARY RESERVOIRS WITH SCS STRUCTURES IN PLACE 1/
FLOOD CONTROL AND RECREATION PROJECT

Item	Flood control	Recreation	Total
	($1,000)	($1,000)	($1,000)
1. Allocation of annual charges			
a. Benefits	436	1,912 2/	2,348
b. Alternate costs	1,327	687	-
c. Benefits limited by alternate costs	436	687	1,123
d. Separable cost	908	268	1,176
e. Remaining benefits	0	419	419
f. Allocation, joint costs	0	419	419
g. Total allocation, economic costs	908	687	1,595
h. Loss of return, lands	124	61	185
i. Total allocation of project costs	784	626	1,410
2. Allocation of O&M costs			
a. Separable costs	68	150	218
b. Allocation of joint costs	0	63	63
c. Total allocation O&M costs	68	213	281 3/
3. Allocation of loss of return, lands			
a. Separable cost	124	0	124
b. Allocation joint cost	0	61	61
c. Total allocation, lands	124	61	185
4. Allocation of investment			
a. Allocation of investment cost	716	413	1,129
b. Investment	21,125	12,195	33,320
5. Allocation of first cost			
a. Interest during construction	983	567	1,550
b. Allocation of first costs	20,142	11,628	31,770
6. Ratio of annual benefits to annual costs	0.5	2.8	1.5

1/ Floodwater retarding structures studied by Soil Conservation Service assumed in place on tributaries not controlled by tributary reservoirs.

2/ Includes $45,000 fish and wildlife benefits.

3/ Includes $36,000 fish and wildlife losses.

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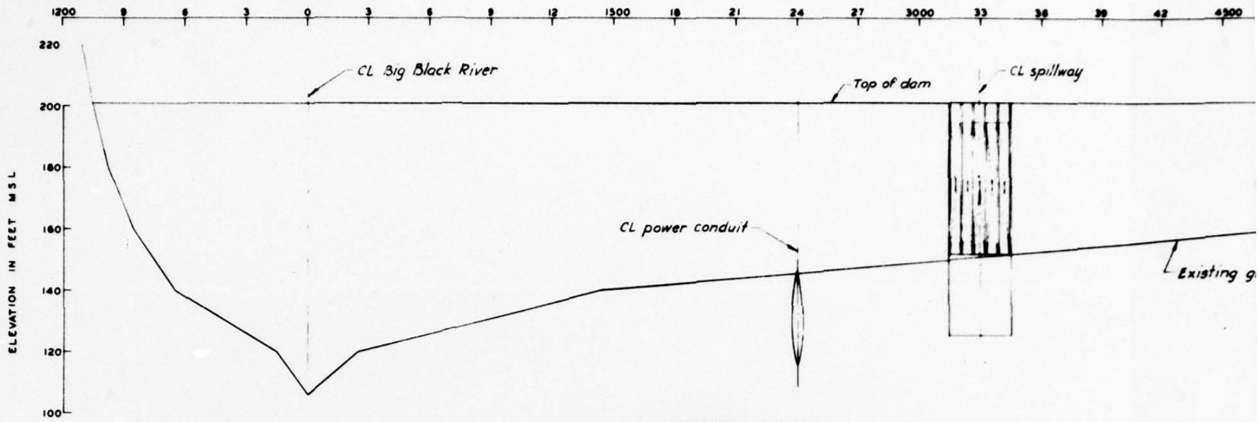

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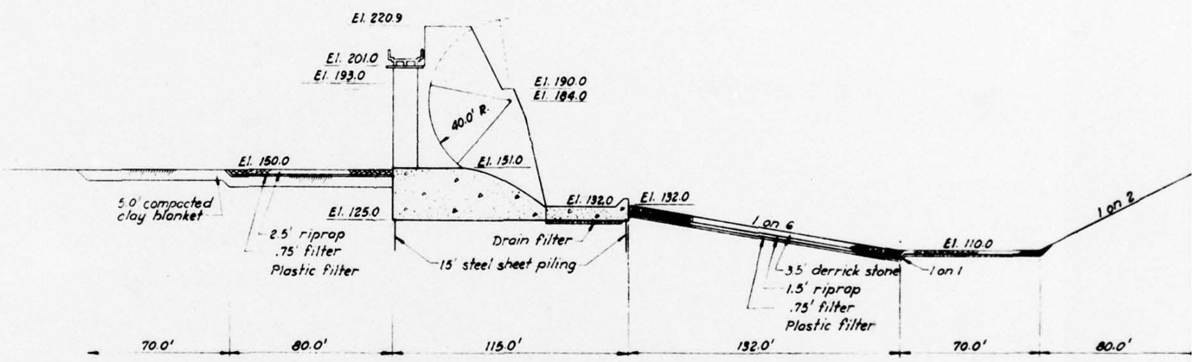

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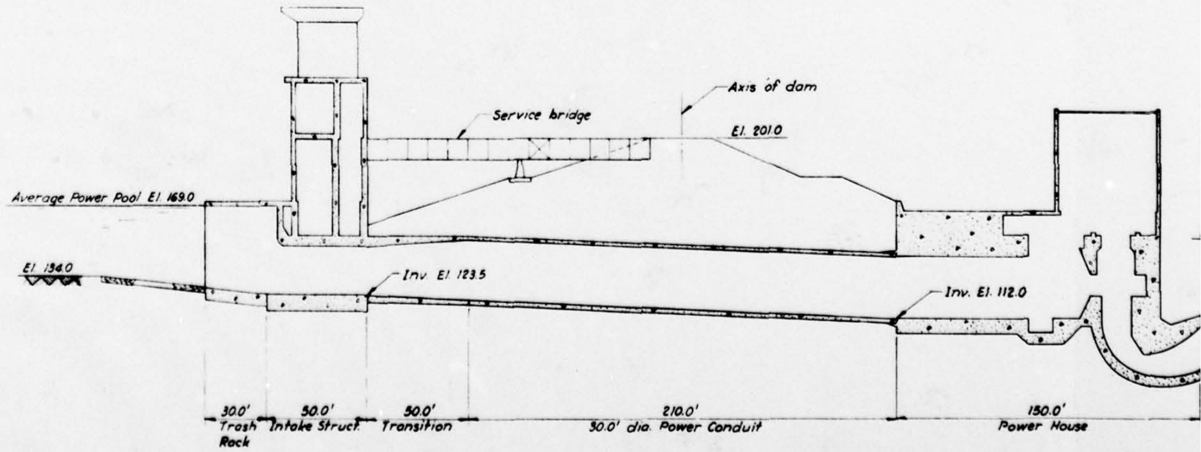

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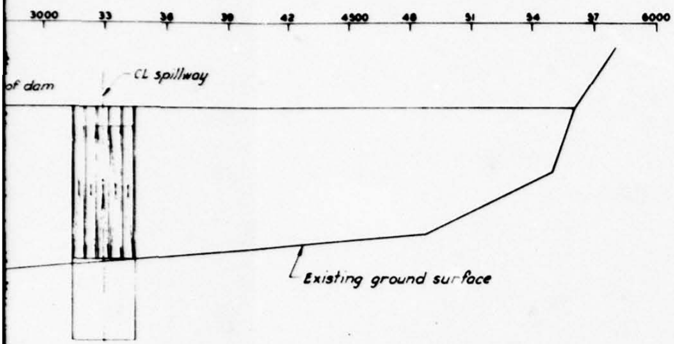

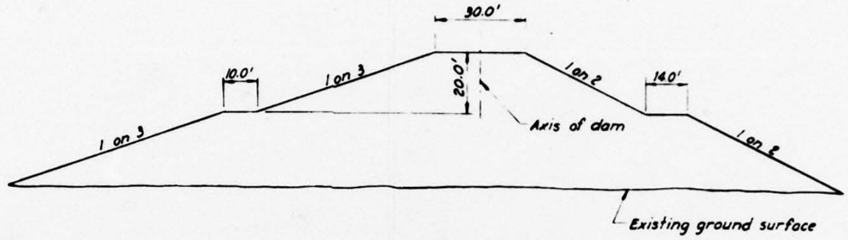

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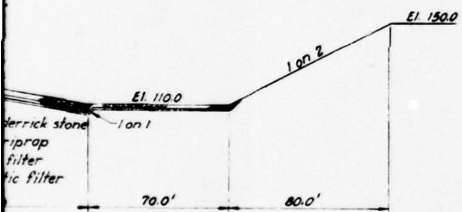

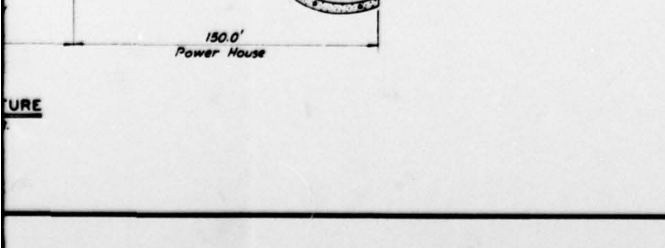

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LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

EDWARDS MAIN STEM RESERVOIR
PROFILE AND SECTIONS

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

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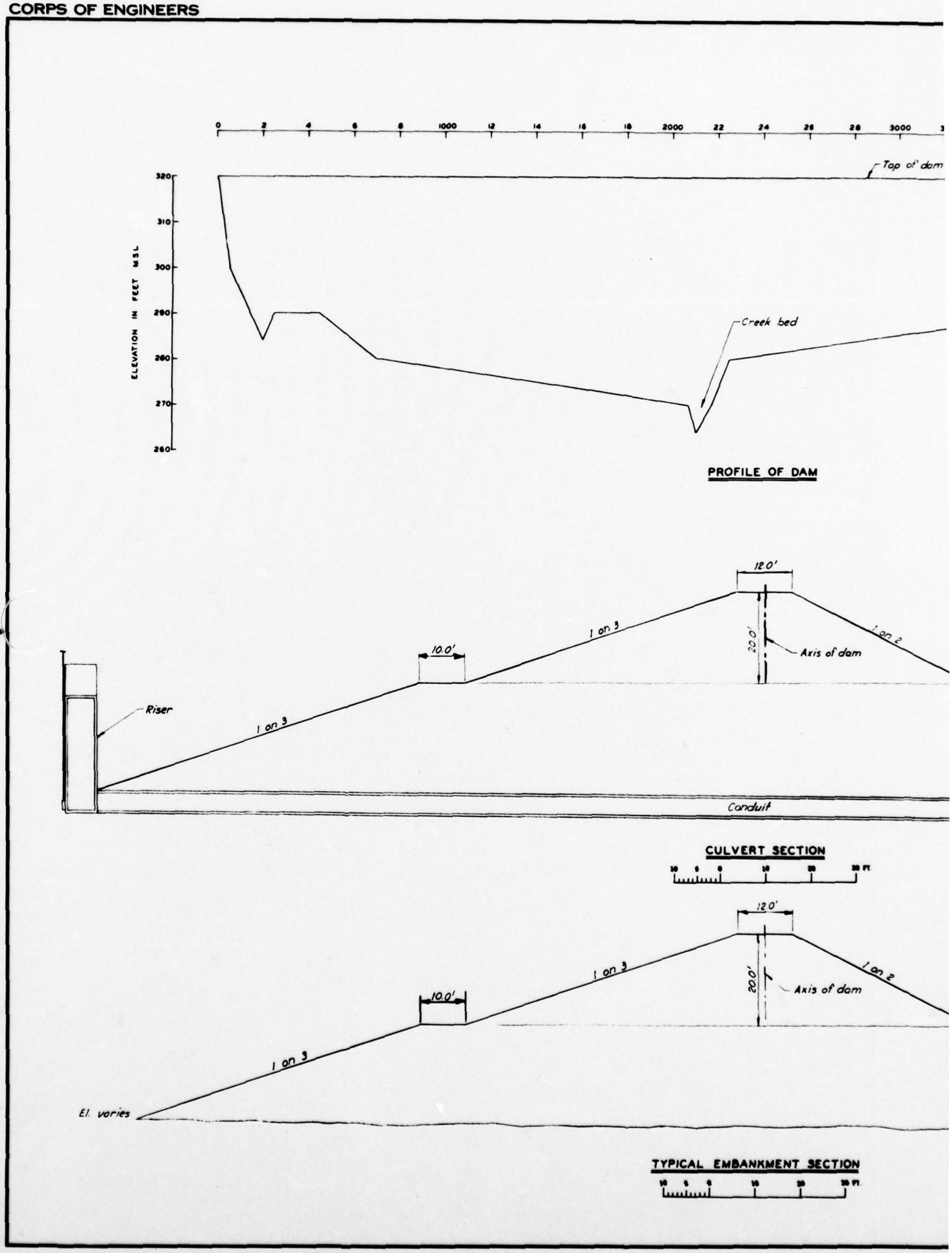
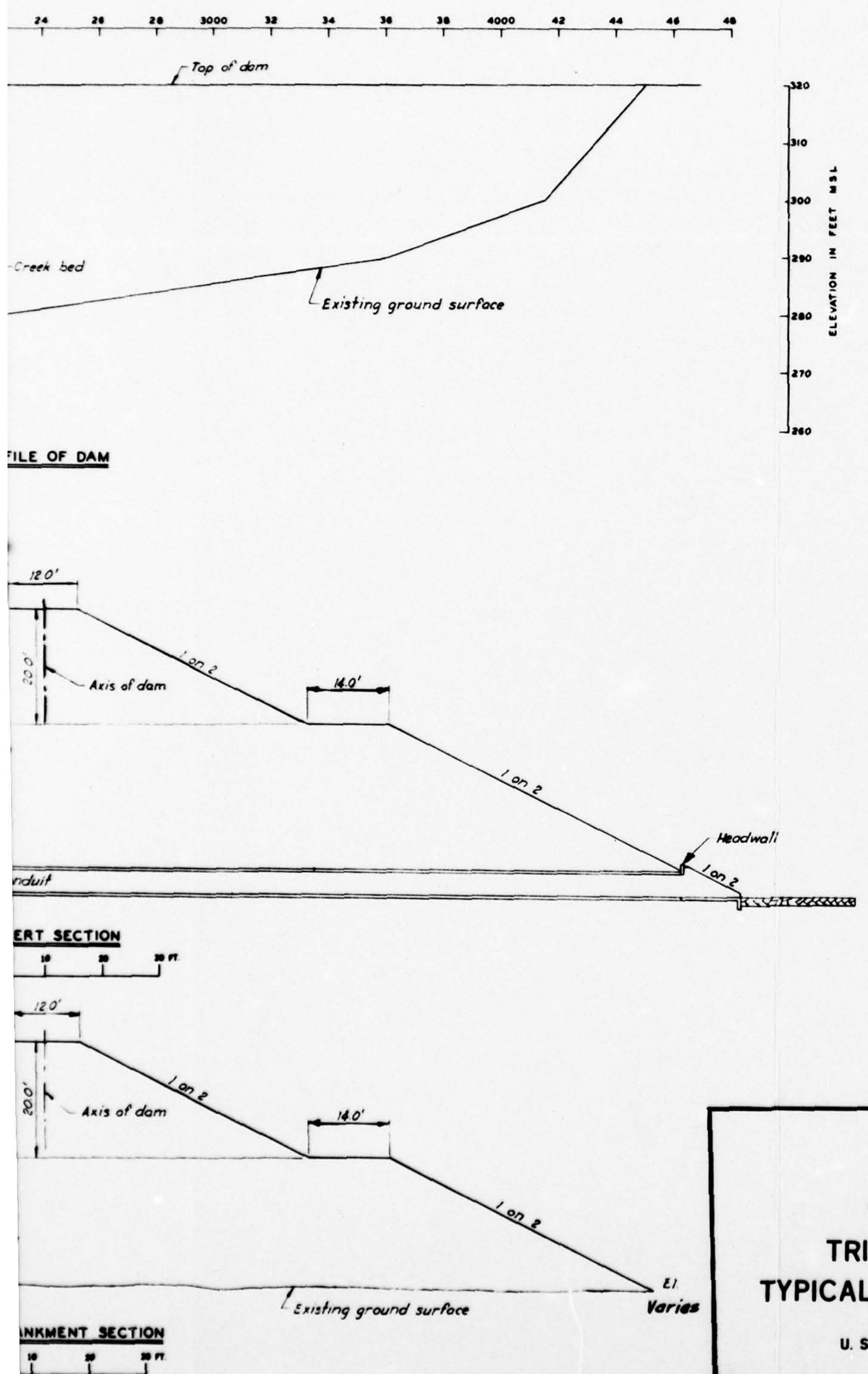
CORPS OF ENGINEERS





LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

TRIBUTARY RESERVOIRS
TYPICAL PROFILE AND SECTIONS

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

APPENDIX G
BIG BLACK RIVER BASIN
GEOLOGY AND SOILS

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APPENDIX G

BIG BLACK RIVER BASIN
GEOLOGY AND SOILS

1. GENERAL

The Big Black River Basin is a long and narrow drainage area in West Central Mississippi located in the Eastern Hills and Bluff Hills section of the Gulf Coastal Plain of the United States. It is approximately 160 miles long and 20 to 25 miles wide. Elevations range from about 60 feet, mean sea level, at the confluence of the Big Black and Mississippi Rivers to more than 500 feet, mean sea level, along the northeastern rim of the basin. The average annual precipitation in the basin is 52 inches and the average annual temperature is 65° F.

2. PHYSIOGRAPHY

The Big Black River Basin is characterized by a belted topography of aligned hills and valleys which parallels the inland border of the Gulf Coastal Plain. The belted topography is a result of the differential erosion of the deltaic deposits exposed at the surface. Generally the hills are well rounded and the flood plains are rather wide.

3. DRAINAGE

Drainage of the Big Black River Basin is tributary to the Mississippi River. The Big Black River flows in a southwesterly direction transverse to the belts of outcrop of the Tertiary formation of the area as shown on Plate G-1. The Big Black River is considered a relatively mature consequent stream or one whose position is the result of the initial slope of the land area. The tributary streams are greatly influenced by the outcrop pattern of the sedimentary Gulf Coastal Plain sediments.

4. STRATIGRAPHY

Sedimentary deposits exhibiting a wide range in geologic age are found within the terrain of the Big Black River Basin. Past studies of these sediments indicate the accumulation of a great seaward-thickening sedimentary wedge (shown on Plate G-2) composed principally of deltaic deposits accumulated upon a basement of older rocks outcropping in the uplands adjacent to the coastal plain. A generalized section of exposed strata in the Big Black River Basin, including age, group and formation names, approximate thickness and lithologic character is given on Table G-1. Plates G-3, G-4, and G-5 present geologic sections constructed from boring data obtained from the Mississippi State Highway Department at bridge locations across the Big Black River at river miles 50.2, 68.3, 140.3, 159.0 and 206.1. These borings

were made by the rotary drilling method, on the dates indicated, using an auger or drive tube and the standard split spoon sampler. The harder limestones and marls were core drilled. The classifications given are field classifications. Water table and split spoon blow counts are given where available. Symbols in the graphic logs are according to the Unified Soils Classification soils and rock borings legend. Plates G-6 and G-7 indicate that the channel grade between the mouth of the river to approximately mile 185 would be concerned primarily with the recent river alluvium. This alluvium varies from approximately 15 feet to in excess of 50 feet in thickness and consists of a fine grained top stratum of clays and silts and grades downward into the silty sands and sands with clay and silt strata. Such descriptive terms as loose, wet, mucky, soft or very soft were frequently used in describing the top stratum material, however, the split spoon blow counts indicate the consistency of the silts range from soft to medium and the clays range from stiff to very stiff. In the outcropping area of the more resistant Glendon limestone it is possible that in localized reaches the alluvium is somewhat thinner than indicated and the river is actually eroding the outcropping limestone strata. Above mile 185 the river channel has cut into Tertiary sediments; however, the Tertiary in this area is composed primarily of loosely consolidated clays, silts and sands with widely scattered thin lenses of sandstone, ironstone or siliceous siltstones and should present no significant channel excavation or foundation problems.

5. STRUCTURE

a. The Tertiary deposits strike Northwest-Southeast parallel to the inland border of the Gulf Coastal Plain and dip gently to the southwest toward the axis of the Mississippi Embayment. Plate G-2 shows how the Tertiary formations thicken and the dip becomes steeper as you approach the axis of the Embayment.

b. In the subsurface the Big Black River geosyncline, located between Warren and Hinds Counties, is a northward extension of the South Mississippi Salt Dome Basin. There is some indication that the geosyncline and the piercement type salt domes have influenced the present course of the Big Black River. More significant, however, is the Pickens-Gilberton fault zone. In April 1940, oil was discovered along this fault zone in the vicinity of Pickens, Mississippi, and is now actively producing oil on both sides of the Big Black River in Yazoo and Madison Counties.

c. Although no direct proof is available at this time, many geologists believe that the abrupt change in course of the Big Black River just south of Interstate Highway 20 is the result of faulting in this area and quite possibly related to the Bliss Creek fault located north of Vicksburg, Mississippi.

6. GROUND WATER CONDITIONS

Water table observations, where available, are shown on the boring logs. Generally the river channel is connected to the substratum sands and the water table is expected to be closely related to the river stages.

7. CONSTRUCTION MATERIALS

An ample supply of concrete aggregate is available from local sources at a reasonable haul distance. No commercial or undeveloped sources of riprap are available in the project area. The nearest known commercial source of acceptable riprap is in the Little Rock, Arkansas, area. Bedding gravel and filter materials are available from local sources.

8. ENGINEERING CONSIDERATIONS

a. Although the areal distribution of the various depositional environments of the Recent Alluvial topstratum has not been developed, certain generalizations can be made. Tertiary materials are more indurated and therefore would provide the stronger foundation horizon. No tests of D_{10} sizes are available for assessment of the permeability. The topstratum clays, silts and Tertiary clays are considered relatively impermeable while the substratum sands and Tertiary sands will be highly permeable, therefore, any excavation for future structure sites may present dewatering or slope stability problems.

b. The average channel side slopes are shown on Plates G-3, G-4, and G-5. Present data indicate that the natural channel banks downstream of the outcrop area of the Glendon formation (approximately 50 miles) will average approximately 1 on 2 side slopes. In the outcrop area of the Glendon formation, the natural channel side slopes are expected to average approximately 1 on 3 as shown on Plate G-4. Upstream of the outcrop area of the Glendon formation, the natural channel side slopes vary between 1 on 1.5 and 1 on 2.

c. The Edwards Dam site is located in the southern half of section 15, T 7 N, R 4 W. Based on information available from the Mississippi Geological Survey Bulletin 105, Hinds County Geology and Mineral Resources, 1965, the following stratigraphic information is presented subject to local variations in thickness and elevations. The top of the Glendon Limestone occurs at approximately elevation 200 (elevation of top of dam) and is approximately 35 feet thick. Underlying the Glendon Limestone is the Mint Spring Marl which is approximately 30 feet thick. Underlying the Mint Spring Marl is the Forest Hill formation approximately 100 feet thick. Based on the above stratigraphic intervals the spillway, intake, conduit and powerhouse will be founded on the upper Forest Hill formation. The bearing capacity of this formation is considered adequate to support the structures considered in this study. Because of the stratified nature of the Forest Hill formation and the relatively thick clay layers, additional investigations

will be necessary to determine the need for seepage relief measures in this formation. Past experience with the Glendon Limestone in the Vicksburg area does not indicate through seepage will be a problem in this formation. However, the limestone layers will break off when exposed in near vertical slopes. Ample embankment material for the Edwards site is available from the Loess and Pre-Loess terrace deposits which cap the hills surrounding the dam site. Examination of the topographic map of the Edwards site indicates the presence of several topographic saddles adjacent to possible dam sites in section 22 or section 27, T 7 N, R 4 W, with the top of the Glendon Limestone at about the spillway crest elevation. These sites should be considered as well as the possible selection of an isolated spillway site adjacent to the main embankment in view of the fact that the excavated material could be used in the main embankment.

d. There are no known geologic problems associated with the tributary reservoir sites. Because of the relatively low heads, no underseepage problems are anticipated.

e. The project area is considered an area of low seismic probability in which only minor damage may be expected from seismic activity.

f. Significant mineral resources of the area such as the Pickens oil field are not affected by the projects considered in this study.

g. Foundation borings were not made at specific sites mentioned in the study; however, based upon a general knowledge of the geologic formations present in the basin and data presented in this report, no significant foundation problems are anticipated.

h. There are no known geologic conditions which would adversely affect engineering structures considered in this study.

APPENDIX G

TABLE G-1
GENERALIZED SECTION OF EXPOSED STRATA IN BIG BLACK RIVER BASIN

Period	System	Group	Formation	Thickness-Feet	Lithologic Character
Quaternary	Recent		Alluvium	0-200	Fine to coarse grained sand, gravel, silt, and clay. Contains organic material in some localities.
Quaternary	Pleistocene		Loess	0- 75	Homogenious unsatratified silty clay and clay silt with occasional lenses of fine sand. Calcareous and contains fossil snail shells. Bluish gray where unoxidized but brownish gray on outcrop.
			Pre-loess Terrace Deposits	0- 80	Chert and quartz gravel; fine to coarse grained sand. Occasional clay lenses. Sand weathers to red color. Contains silicified wood in some localities.
			Citronelle	0- 20	Chert and quartz gravel; fine to coarse grained sand.
	Miocene		Catahoula	100-500	An interfingering complex of sands and sandstones, silts, and silt-stones, clay and claystones, laid down in estuarine, continental, and deltaic environments.
	Oligocene	Vicksburg			Bucatunna Clay Member (30-40 feet). Dark brown, lignitic, plastic clay of marine or estuarine origin with a few thin siltstone and claystone layers.
			Byram	90-120	Middle Marl Member (40-50 feet).

Miocene				and sandstones, silts, and silt-stones, clay and claystones, laid down in estuarine, continental, and deltaic environments.
Oligocene	Vicksburg			Bucatunna Clay Member (30-40 feet). Dark brown, lignitic, plastic clay of marine or estuarine origin with a few thin siltstone and claystone layers.
		Byram	90-120	Middle Marl Member (40-50 feet). Highly fossiliferous marine clay and sandy marl with zones of nodular or lenticular hard limestone. Also referred to as "Byram marl".
				Glendon Limestone Member (30-40 feet). Alternating strata of hard, sandy limestone and clayey, sandy marl. Individual limestone layers less than 5 feet thick.
		Marianna	20	Mint Spring Marl Member. Fossiliferous, sandy and clayey marl with occasional phospatic and lignitic pebbles.
		Forest Hill	50-250	A clayey lignitic silt interbedded with fine-grained cross-bedded sand. Contains thin layers of clayey lignities, and lignitic leaf-bearing silty clay.
	Jackson	Yazoo	400-525	Massive, fairly homogeneous unit of blue-green to blue-gray, calcareous, fossiliferous, montmorillonitic, plastic clay. Silty clay irregularly dispersed throughout the section. Thin layers of bentonite may occur in upper section.
		Moody's Branch	10- 45	A very calcareous, fossiliferous, clayey, glauconitic sand. Contains partly indurated layers of soft, sandy, clayey limestone in some areas.
		Cockfield	225-550	Highly lenticular non-marine and shale. The basal portion consists of massive to highly cross-bedded iron-stained sands. The upper portion is predominantly carbona-ceous and lignitic shales with lenses of greenish to light gray, lignitic, leaf bearing clays and

2

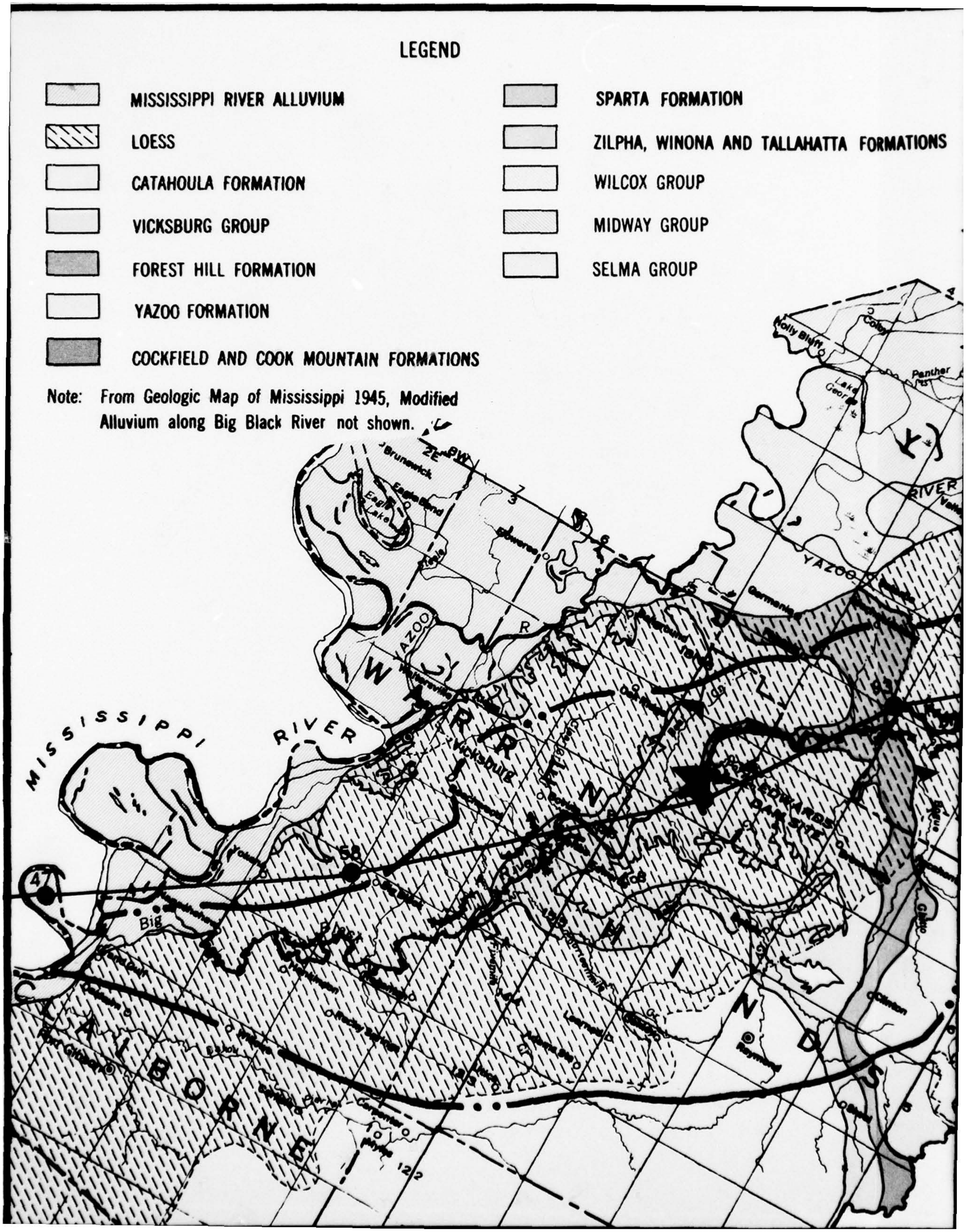
2

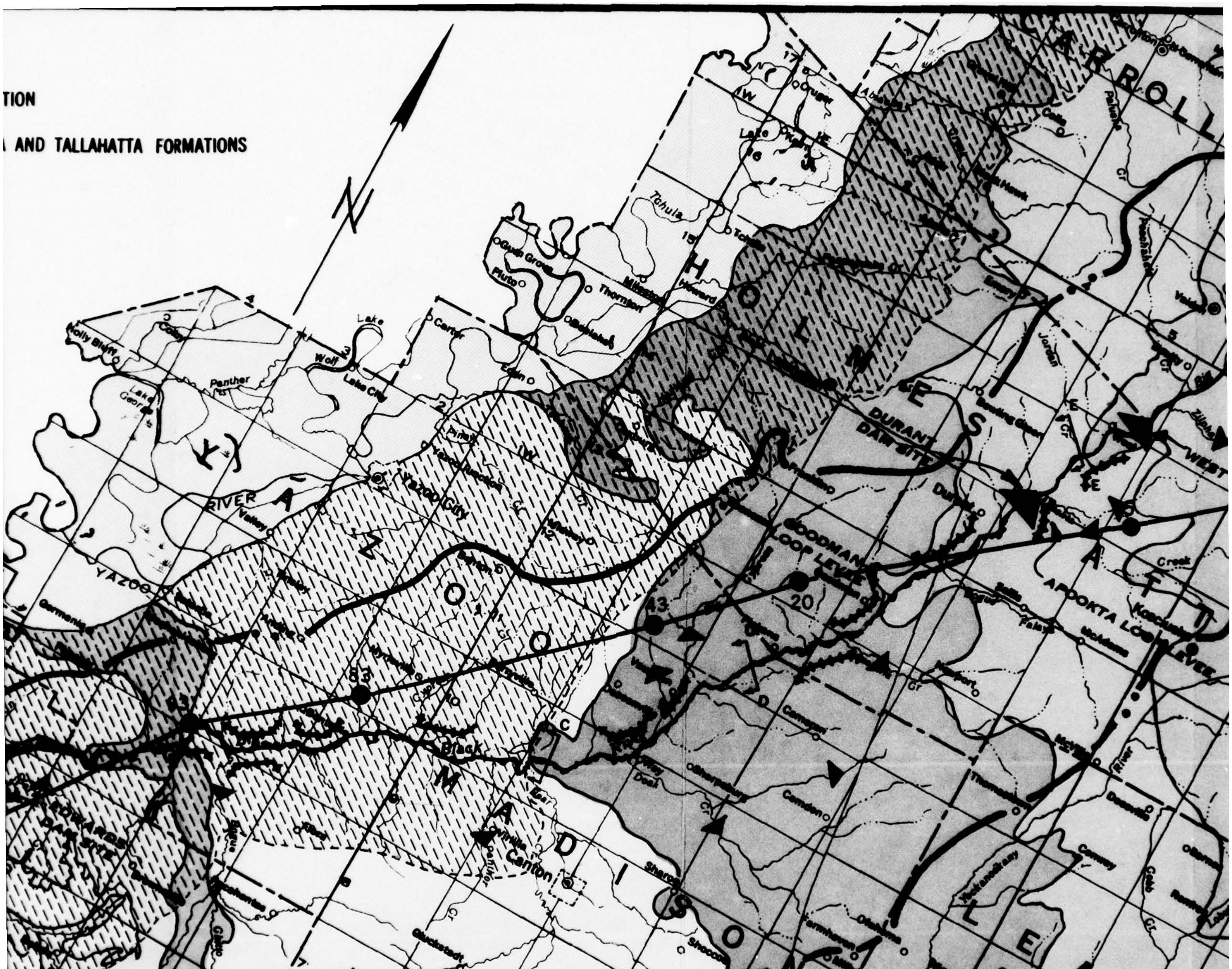
3

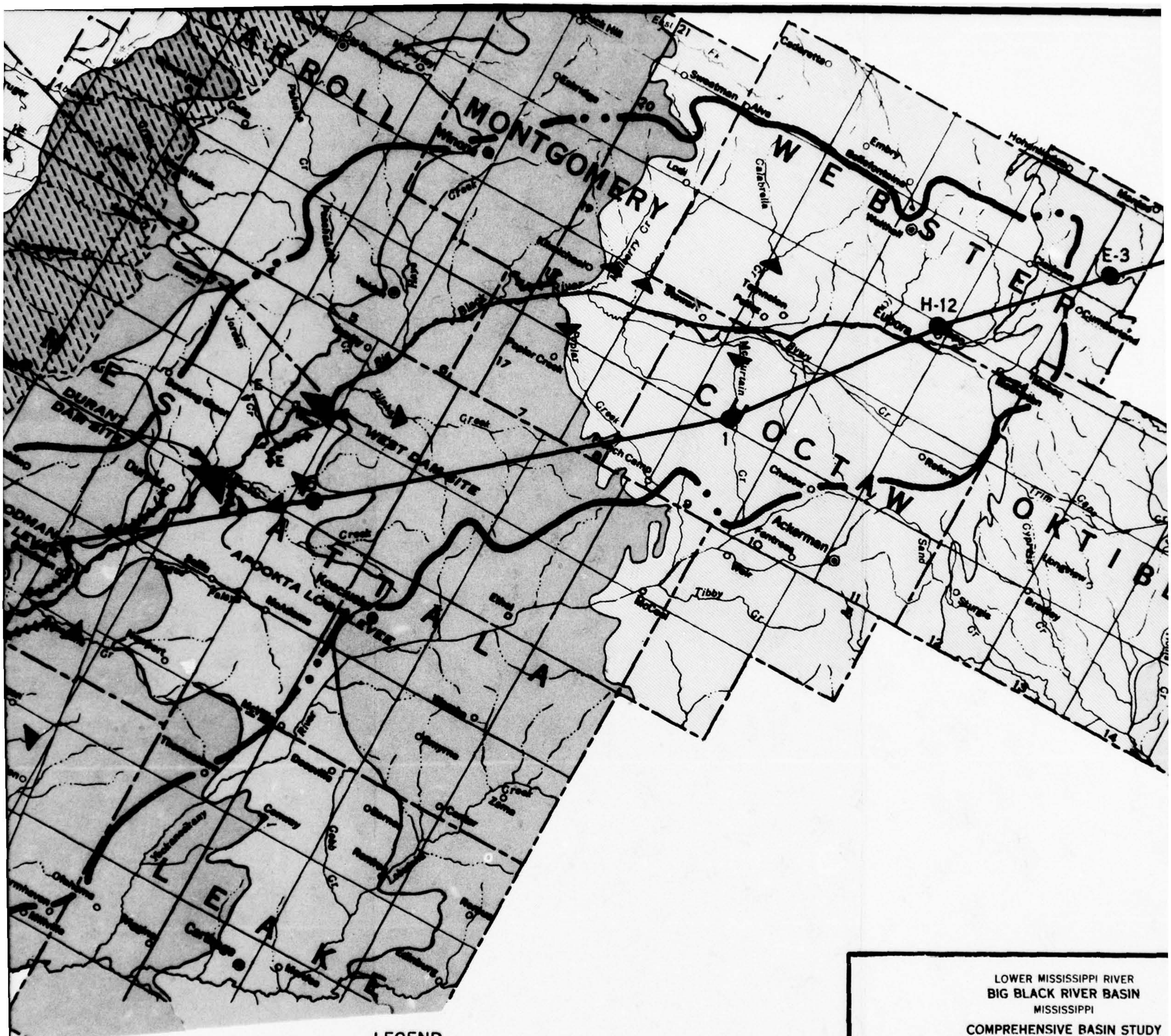
					plastic clay. Silty clay irregularly dispersed throughout the section. Thin layers of bentonite may occur in upper section.
			Moody's Branch	10- 45	A very calcareous, fossiliferous, clayey, glauconitic sand. Contains partly indurated layers of soft, sandy, clayey limestone in some areas.
			Cockfield	225-550	Highly lenticular non-marine and shale. The basal portion consists of massive to highly cross-bedded iron-stained sands. The upper portion is predominantly carbonaceous and lignitic shales with lenses of greenish to light gray, lignitic, leaf bearing clays and silty clays. Black impure lignitic beds as well as limonitic sandstone and siltstone concreations are common.
			Cook Mountain (Watubbee)	80-100	Predominantly carbonaceous clay shale and clay silt and non-glauconic sand. Occasional small lenses, stringers, and pockets of glauconitic clay shale.
Tertiary	Eocene	Claiborne	Sparta (Kosciusko)	240-280	A heterogeneous body made up chiefly of sand, silt, clay shale, and clay. Sand is the predominate facies and the silt-clay facies are developed locally as lenticular bodies. Sand is prominent in the lower part and silt clay in the middle.
			Zilpha	15-105	Thick continental unit consisting of well-bedded, tan to chocolate brown carbonaceous silts and clays with lenses of lignite and fine to coarse grained sand. Contains lentils of quartzite and an abundance of plant leaf impressions and lignitized wood. Lower unit consists of interbedded clays and blauconitic silts and sands with claystone fragments.
			Winona	15- 35	Glauconitic sand and green sand locally fossiliferous. Weathers to a red brown or brick red. Rusty sand that at places contains irregular thin beds and masses of limonitic sandstone and sandy iron-

Eo				of well-bedded, tan to chocolate brown carbonaceous silts and clays with lenses of lignite and fine to coarse grained sand. Contains lentils of quartzite and an abundance of plant leaf impressions and lignitized wood. Lower unit consists of interbedded clays and blauconitic silts and sands with claystone fragments.
		Winona	15- 35	Glauconitic sand and green sand locally fossiliferous. Weathers to a red brown or brick red. Rusty sand that at places contains irregular thin beds and masses of limonitic sandstone and sandy ironstone.
				Neshoba sand member. Chiefly sand containing lenses of clay shale, silt and clay.
		Tallahatta	75-140	Basic city shale member. Siliceous claystone, clay shale, siliceous sand, and quartzitic siltstone and sandstone.
				Meridian sand member. Chiefly containing lenses of basic city type sediments and of clay shale and clay.
	Wilcox	Hatchetigbee	to- 75	A heterogeneous body made up of alternations and successions of clay, silt, sand and lignite with the clays and silts predominating.
Paleocene	Midway	Porters Creek		Dark gray to black, carbonaceous clay, slightly silty and glauconitic with micaceous sand lenses.

4


LEGEND
MISSISSIPPI RIVER ALLUVIUM
LOESS
CATAHOULA FORMATION
VICKSBURG GROUP
FOREST HILL FORMATION
YAZOO FORMATION
COCKFIELD AND COOK MOUNTAIN FORMATIONS
SPARTA FORMATION
ZILPHA, WINONA AND TALLAHATTA FORMATIONS
WILCOX GROUP
MIDWAY GROUP
SELMA GROUP
Note: From Geologic Map of Mississippi 1945, Modified
Alluvium along Big Black River not shown.
MISSISSIPPI
RIVER
YAZOO
RIVER
Vicksburg
EDWARDS
DAM SITE
WARREN
HINDS
CLAIBORNE
Big
Black
47
58


TION
A AND TALLAHATTA FORMATIONS
N
CARROLL
HOLMES
YAZOO
MADISON
LEAKE
ATTALA
DURANT DAM SITE
GOODMAN LOOP LEVEE
APOOKTA LOOP LEVEE
Yazoo City
Canton
JACKSON
Pearl River
Black
Tchula
Lexington
Durant
Kosciusko
Carthage
Ridgeland
Madison
Flora
Sharon
Pickens
Goodman
43
20
63
SCALE
10
0
10
Miles
LEG
Main Ste
Tributary
Limits of
Local Pro
A
A
Borings



LEGEND

- Main Stem Reservoir Sites
- Tributary Reservoir Sites
- Limits of Channel Improvement Plans
- Local Protection Projects (Loop Levees)
- A — A Borings

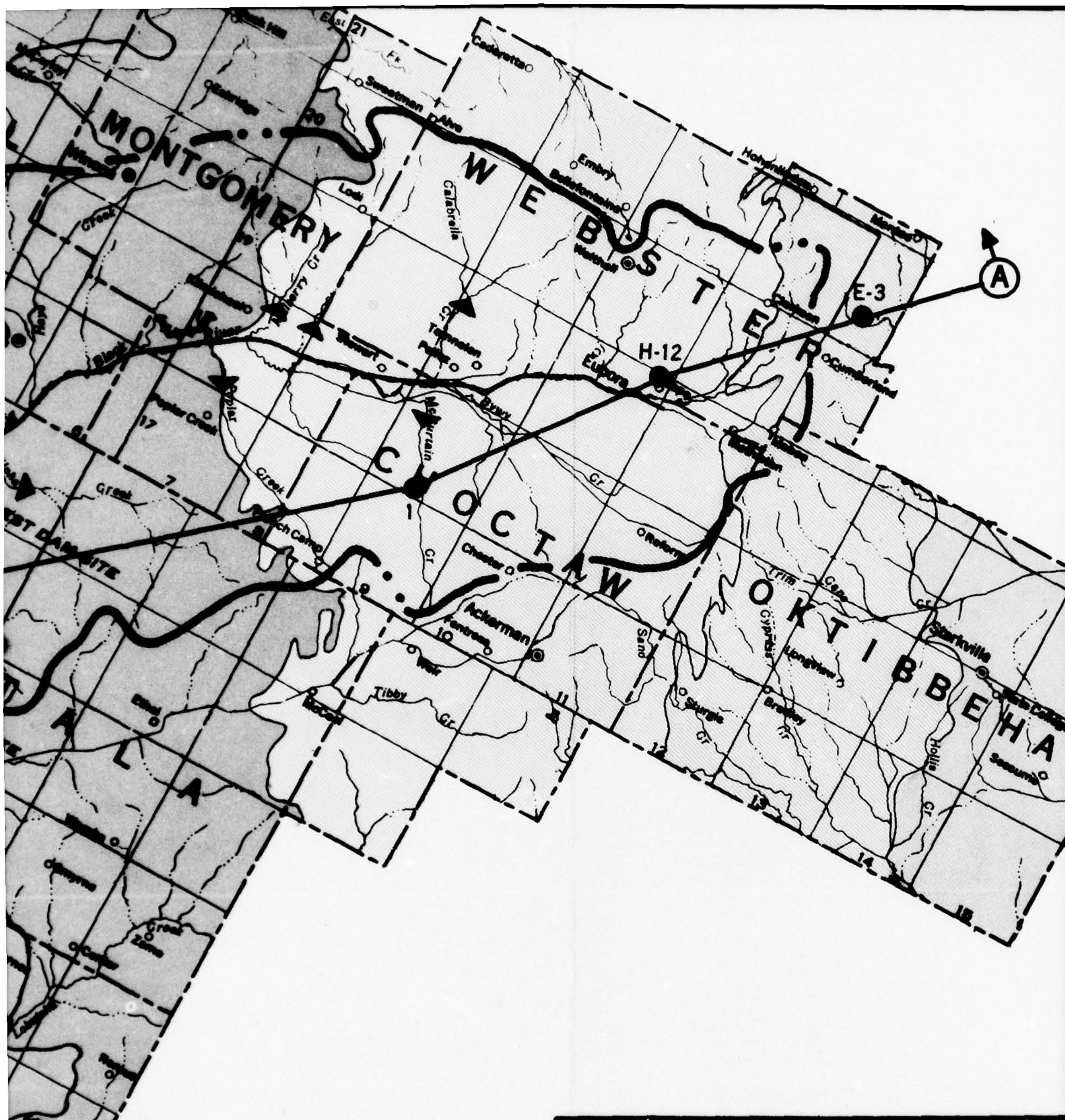
LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

GEOLOGIC MAP

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBU
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO.



EGEND

) Stem Reservoir Sites

tary Reservoir Sites

s of Channel Improvement Plans

) Protection Projects (Loop Levees)

gs

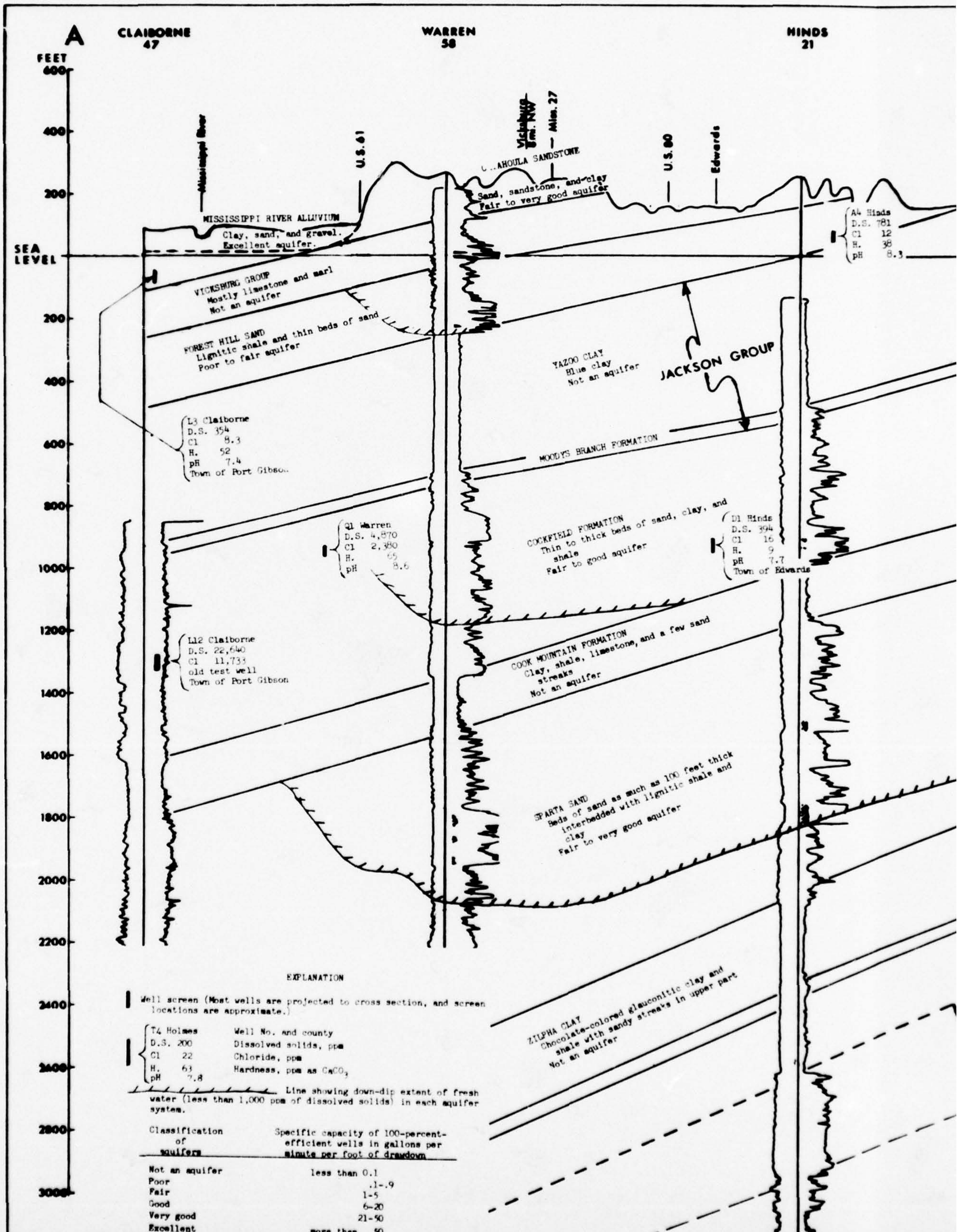
LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

GEOLOGIC MAP

SCALE AS SHOWN

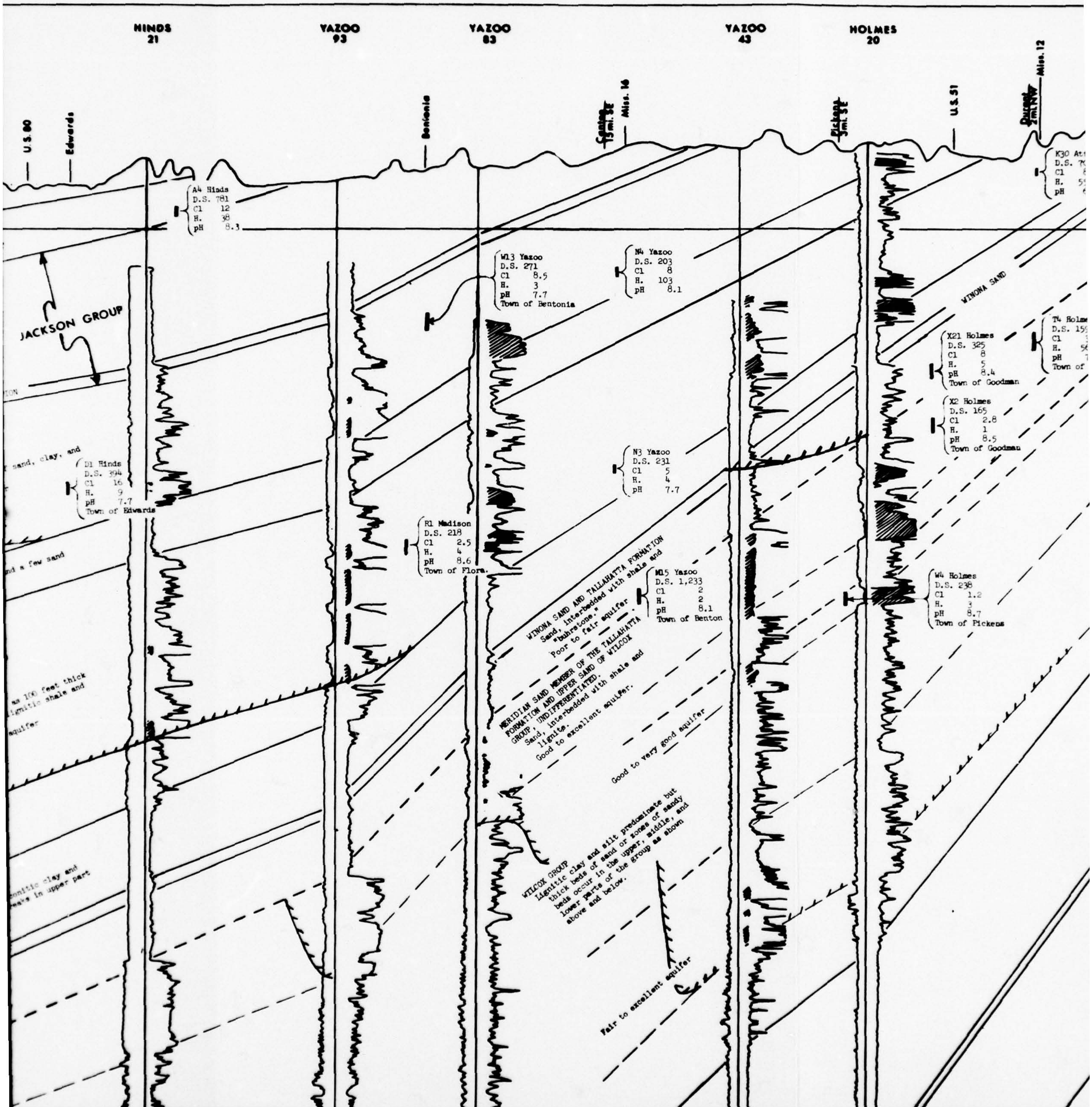
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

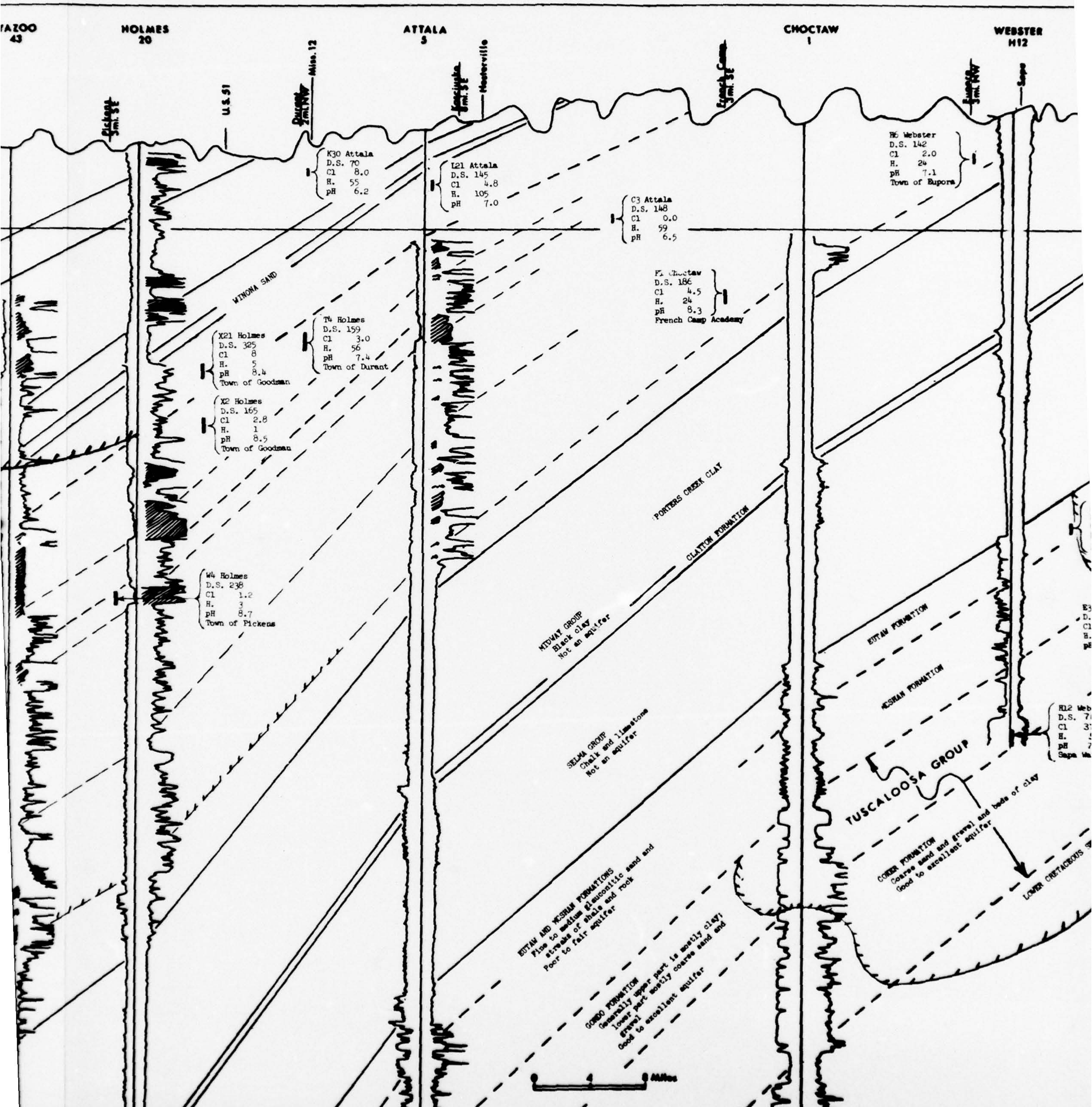


A
CLAIBORNE
47
WARREN
58
HINDS
21
FEET
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
Mississippi River
U.S. 61
Vicksburg
Miss. 27
U.S. 80
Edwards
MISSISSIPPI RIVER ALLUVIUM
Clay, sand, and gravel.
Excellent aquifer.
AHOULA SANDSTONE
Sand, sandstone, and clay
Fair to very good aquifer
A4 Hinds
D.S. 781
Cl 12
H. 38
pH 8.3
VICKSBURG GROUP
Mostly limestone and marl
Not an aquifer
FOREST HILL SAND
Lignitic shale and thin beds of sand
Poor to fair aquifer
YAZOO CLAY
Blue clay
Not an aquifer
JACKSON GROUP
L3 Claiborne
D.S. 354
Cl 8.3
H. 52
pH 7.4
Town of Port Gibson
MOODYS BRANCH FORMATION
Q1 Warren
D.S. 4,870
Cl 2,380
H. 65
pH 8.6
COCKFIELD FORMATION
Thin to thick beds of sand, clay, and shale
Fair to good aquifer
D1 Hinds
D.S. 394
Cl 16
H. 9
pH 7.7
Town of Edwards
L12 Claiborne
D.S. 22,640
Cl 11,733
old test well
Town of Port Gibson
COOK MOUNTAIN FORMATION
Clay, shale, limestone, and a few sand streaks
Not an aquifer
SPARTA SAND
Beds of sand as much as 100 feet thick interbedded with lignitic shale and clay
Fair to very good aquifer
ZILPHA CLAY
Chocolate-colored glauconitic clay and shale with sandy streaks in upper part
Not an aquifer
EXPLANATION
Well screen (Most wells are projected to cross section, and screen locations are approximate.)
T4 Holmes Well No. and county
D.S. 200 Dissolved solids, ppm
Cl 22 Chloride, ppm
H. 63 Hardness, ppm as CaCO3
pH 7.8
Line showing down-dip extent of fresh water (less than 1,000 ppm of dissolved solids) in each aquifer system.
Classification of aquifers
Specific capacity of 100-percent-efficient wells in gallons per minute per foot of drawdown
Not an aquifer less than 0.1
Poor .1-.9
Fair 1-5
Good 6-20
Very good 21-50
Excellent more than 50

2

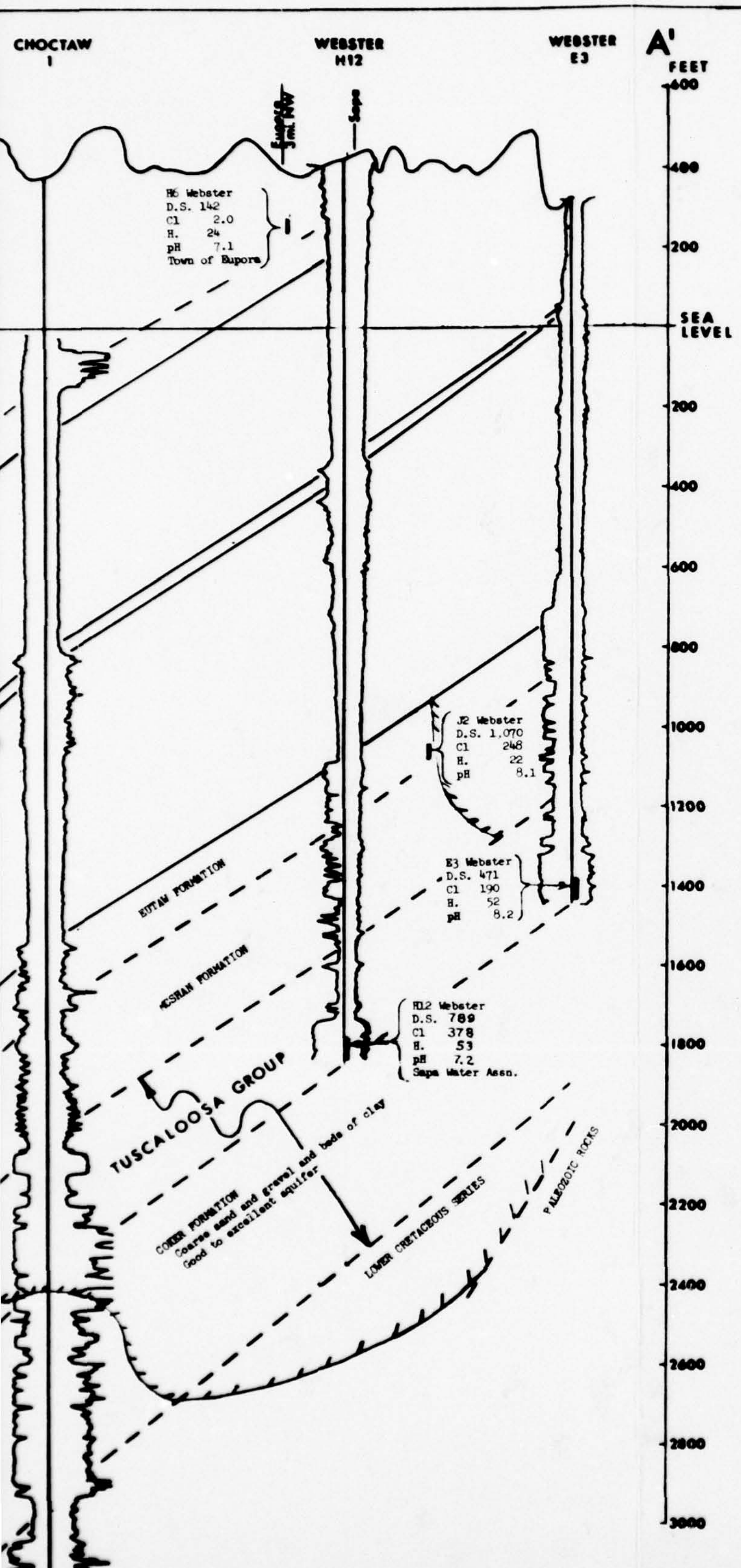

HINDS 21
YAZOO 93
YAZOO 83
YAZOO 43
HOLMES 20
U.S. 80
Edwards
Bentonia
Canton 15 mi. SE
Miss. 16
Pickens 3 mi. SE
U.S. 51
Durant 2 mi. NW
Miss. 12
A4 Hinds
D.S. 781
Cl 12
H. 38
pH 8.3
W13 Yazoo
D.S. 271
Cl 8.5
H. 3
pH 7.7
Town of Bentonia
N4 Yazoo
D.S. 203
Cl 8
H. 103
pH 8.1
JACKSON GROUP
WINONA SAND
X21 Holmes
D.S. 325
Cl 8
H. 5
pH 8.4
Town of Goodman
X2 Holmes
D.S. 165
Cl 2.8
H. 1
pH 8.5
Town of Goodman
D1 Hinds
D.S. 394
Cl 16
H. 9
pH 7.7
Town of Edwards
N3 Yazoo
D.S. 231
Cl 5
H. 4
pH 7.7
R1 Madison
D.S. 218
Cl 2.5
H. 4
pH 8.6
Town of Flora
M15 Yazoo
D.S. 1,233
Cl 2
H. 2
pH 8.1
Town of Benton
W4 Holmes
D.S. 238
Cl 1.2
H. 3
pH 8.7
Town of Pickens
WINONA SAND AND TALLAHATTA FORMATION
Sand, interbedded with shale and "buhrstone."
Poor to fair aquifer
MERIDIAN SAND MEMBER OF THE TALLAHATTA FORMATION AND UPPER SAND OF WILCOX GROUP, UNDIFFERENTIATED.
Sand, interbedded with shale and lignite.
Good to excellent aquifer.
Good to very good aquifer
WILCOX GROUP
Lignitic clay and silt predominate but thick beds of sand or zones of sandy beds occur in the upper, middle, and lower parts of the group as shown above and below.
Fair to excellent aquifer
sand, clay, and
nd a few sand
as 100 feet thick
lignitic shale and
aquifer
gnitic clay and
eaks in upper part

2



YAZOO 43
HOLMES 20
ATTALA 5
CHOCTAW 1
WEBSTER H12
U.S. 51
Miss. 12
Kosciusko
Mcadamsville
K30 Attala
D.S. 70
Cl 8.0
H. 55
pH 6.2
L21 Attala
D.S. 145
Cl 4.8
H. 105
pH 7.0
C3 Attala
D.S. 148
Cl 0.0
H. 59
pH 6.5
H6 Webster
D.S. 142
Cl 2.0
H. 24
pH 7.1
Town of Eupora
D.S. 186
Cl 4.5
H. 24
pH 8.3
French Camp Academy
WINONA SAND
X21 Holmes
D.S. 325
Cl 8
H. 5
pH 8.4
Town of Goodman
T4 Holmes
D.S. 159
Cl 3.0
H. 56
pH 7.4
Town of Durant
X2 Holmes
D.S. 165
Cl 2.8
H. 1
pH 8.5
Town of Goodman
W4 Holmes
D.S. 238
Cl 1.2
H. 3
pH 8.7
Town of Pickens
PORTERS CREEK CLAY
CLAYTON FORMATION
MIDWAY GROUP
Black clay
Not an aquifer
EUTAW FORMATION
MCSHAN FORMATION
SELMA GROUP
Chalk and limestone
Not an aquifer
TUSCALOOSA GROUP
EUTAW AND MCSHAN FORMATIONS
Fine to medium glauconitic sand and
streaks of shale and rock
Poor to fair aquifer
COKER FORMATION
Coarse sand and gravel and beds of clay
Good to excellent aquifer
LOWER CRETACEOUS
GORDO FORMATION
Generally upper part is mostly clay;
lower part mostly coarse sand and
gravel
Good to excellent aquifer
0 4 8 Miles

3



NOTE:
From Geology and Water Resources of the Big Black River Basin by the U.S. Geological Survey Water Resources Division, 1966.

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

GEOLOGIC PROFILE

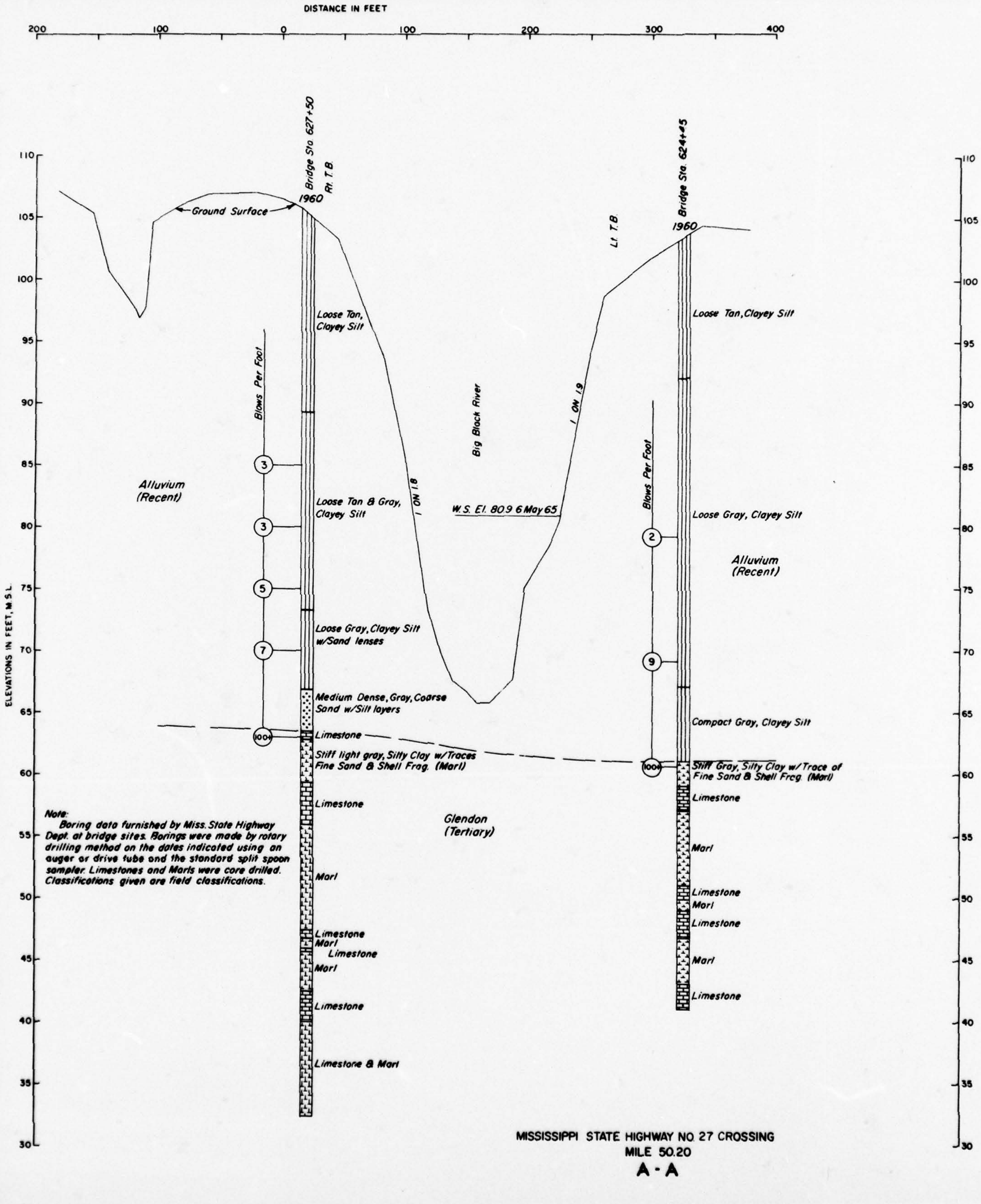
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

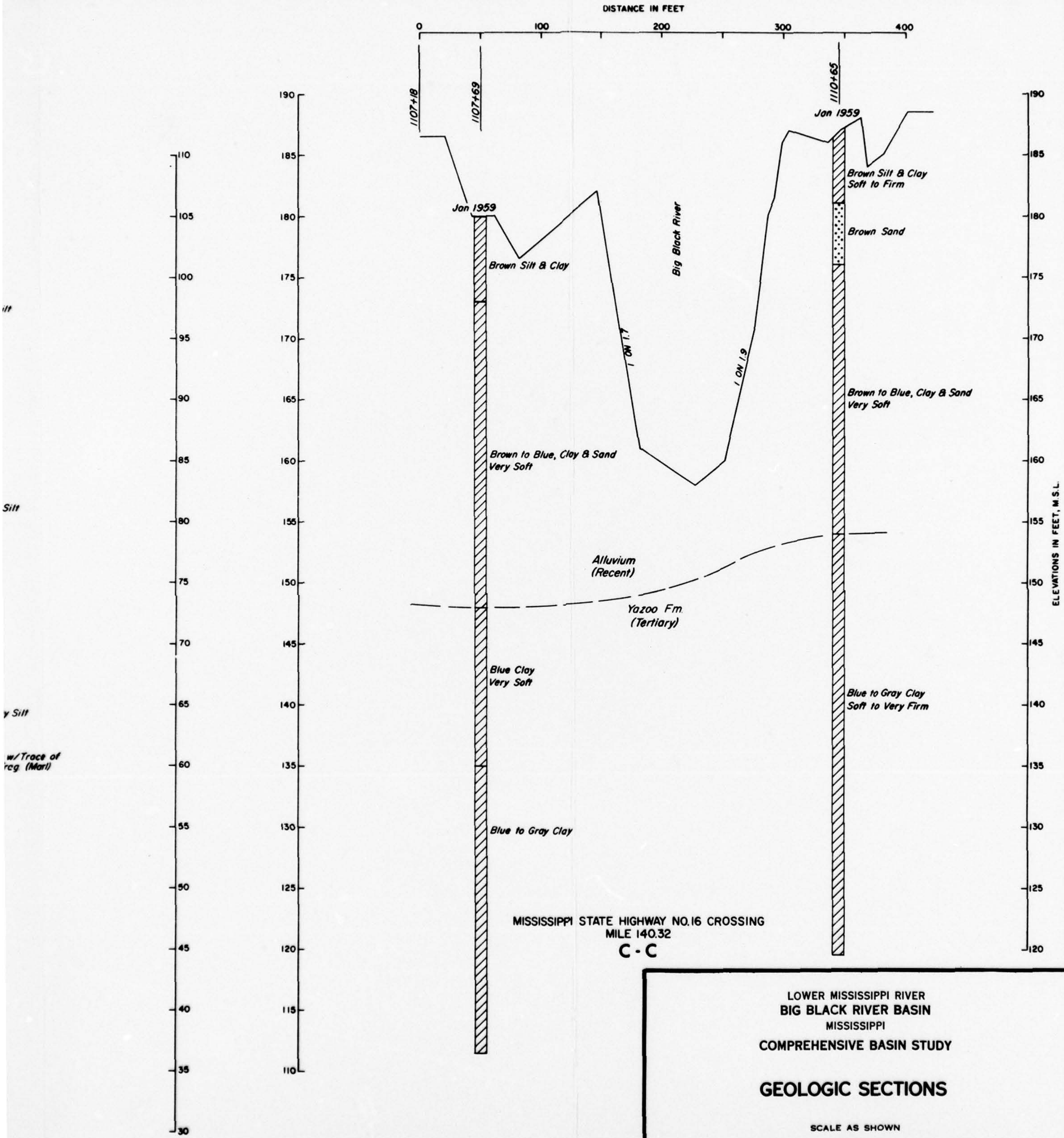
FILE NO. BB-14-9

PLATE G-2

4



MISSISSIPPI STATE HIGHWAY NO. 27 CROSSING
MILE 50.20
A - A



MISSISSIPPI STATE HIGHWAY NO.16 CROSSING
MILE 140.32
C - C

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

GEOLOGIC SECTIONS

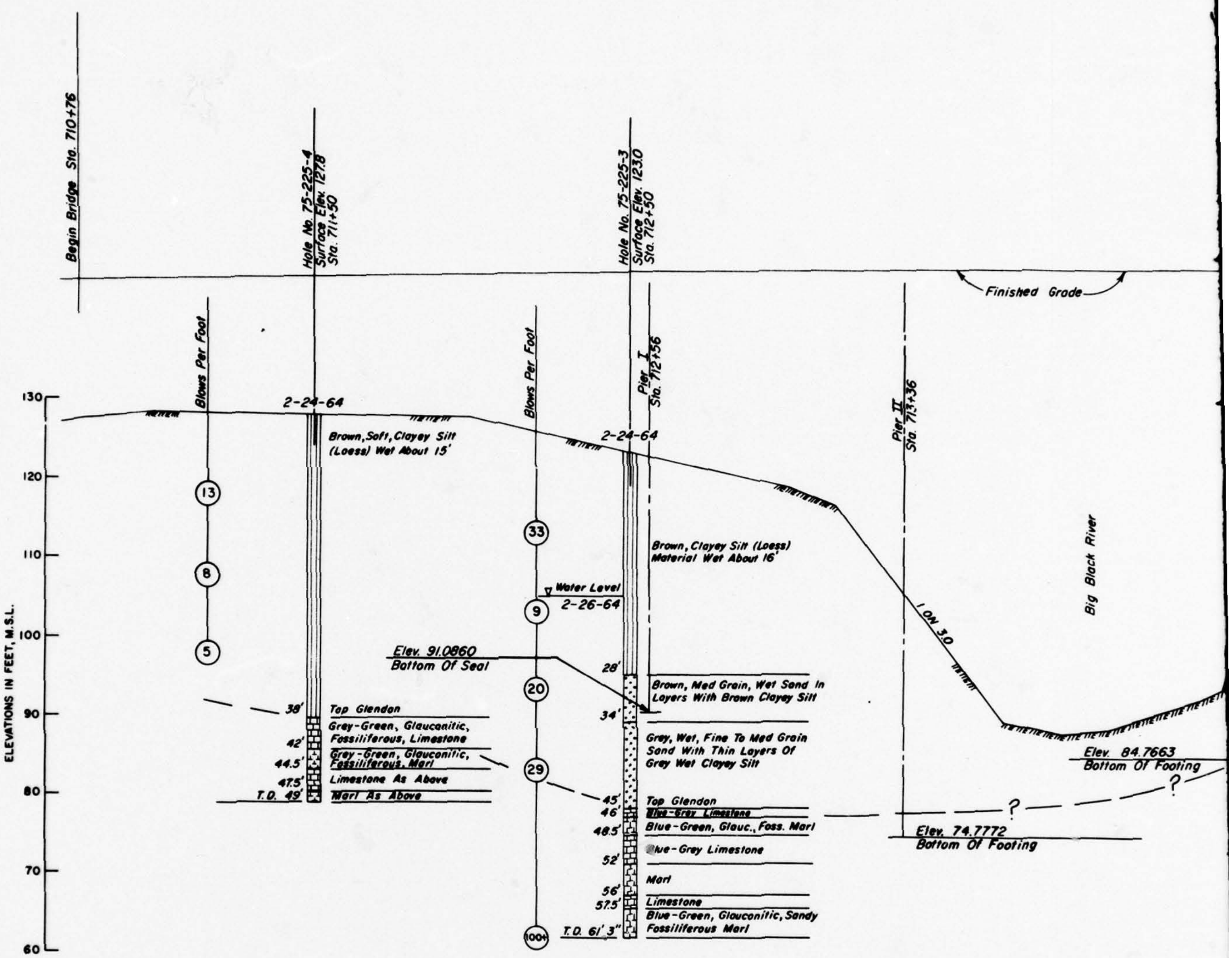
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

2

FILE NO. BB-14-9

PLATE G-3

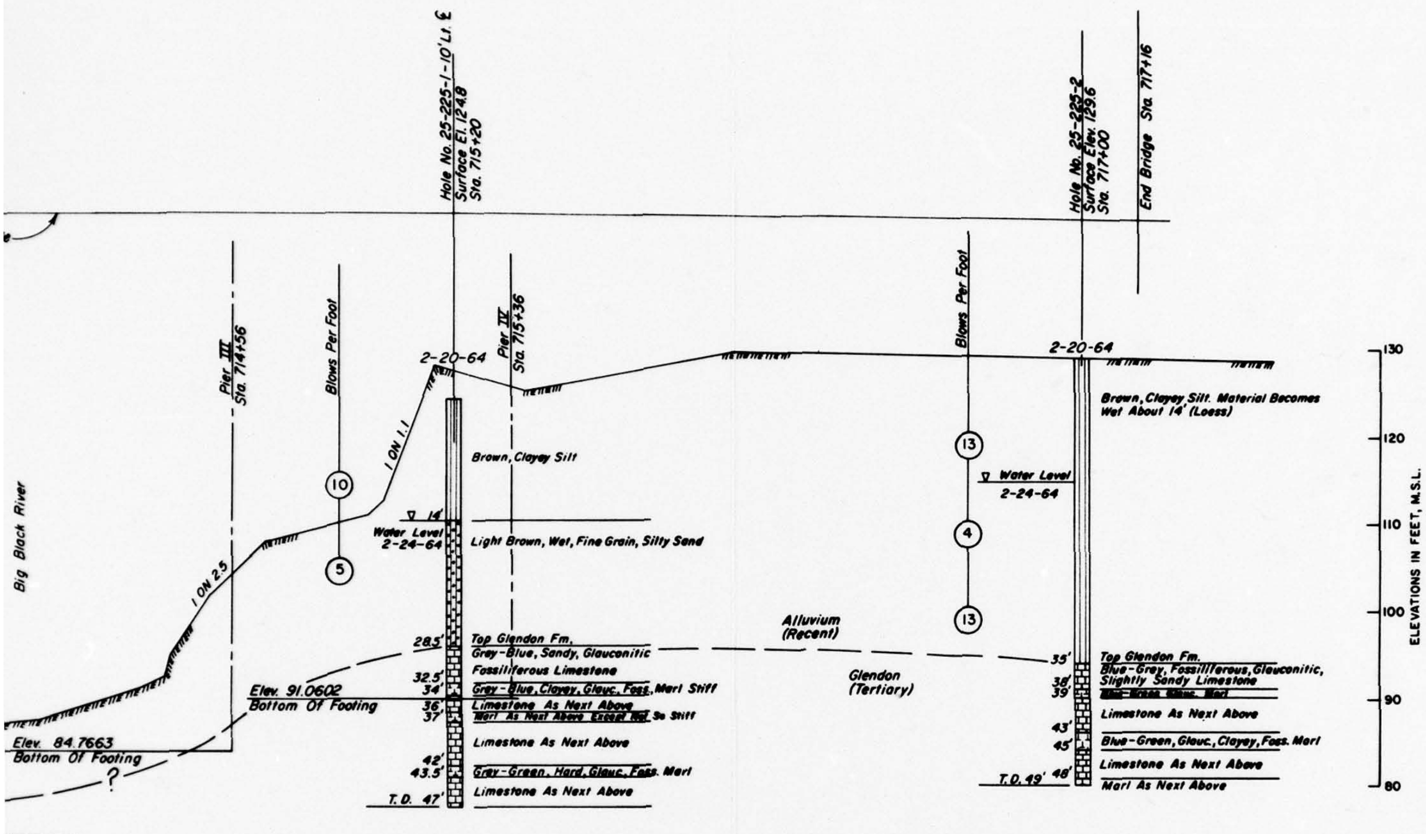


Note:
Boring data furnished by Miss. State Highway Department at bridge sites. Borings were made by rotary drilling method on the dates indicated using an auger or drive tube and the standard split spoon sampler. Limestones and Marls were core drilled. Classifications given are field classifications.

INTERSTATE HIGHWAY I-20 CROSSING
MILE 68.25

B - B

SCALES
1" = 25' Horizontal
1" = 10' Vertical



OSSING

Note:
Boring Data Shown Is For Information Only And Its Accuracy For Construction Purposes Is Not Guaranteed.

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

GEOLOGIC SECTION

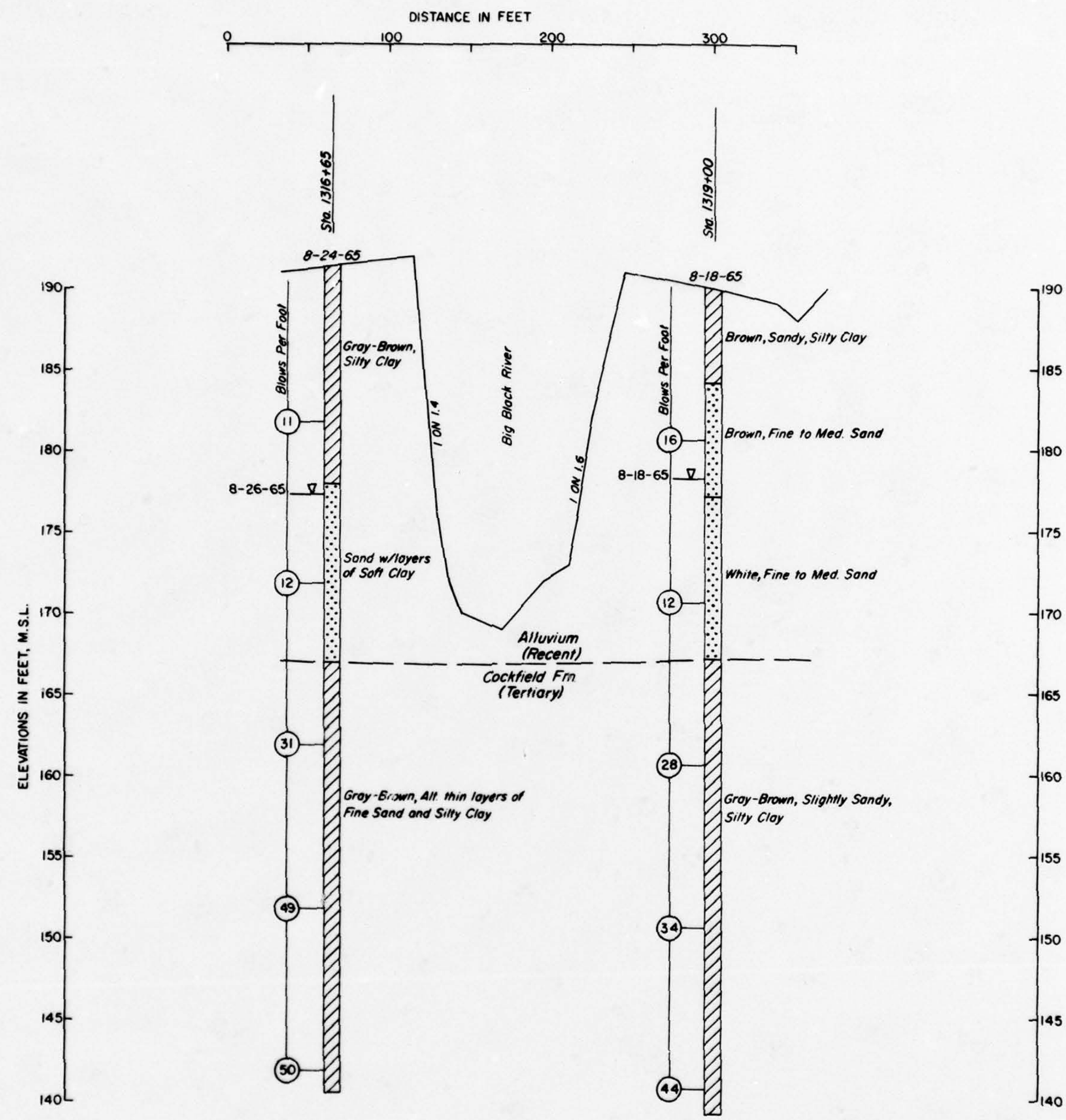
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

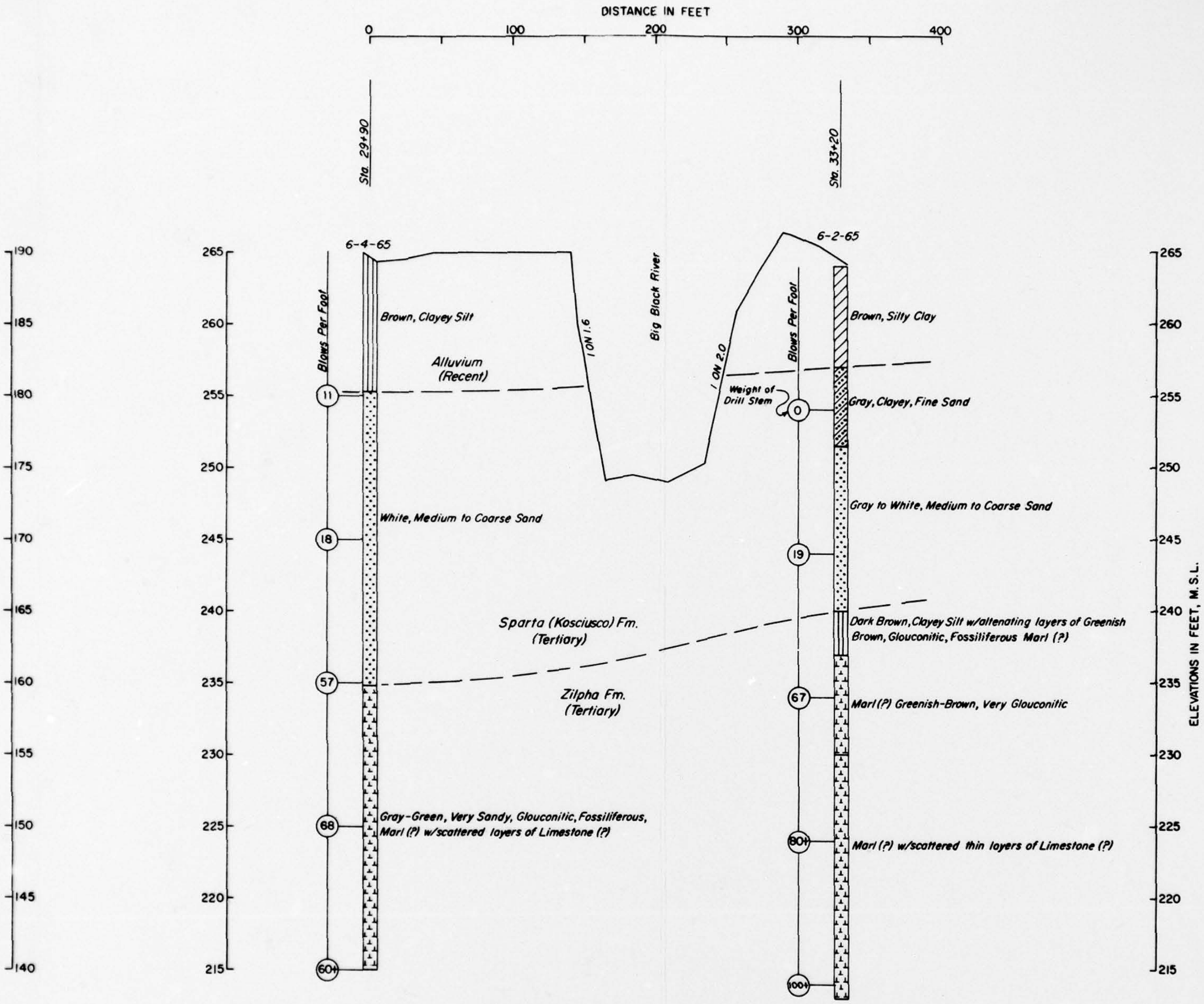
2

PLATE G-4



INTERSTATE HIGHWAY I-55 CROSSING
MILE 159.0
D - D

Note:
Boring data furnished by the Miss. State Hwy. Dept. at bridge sites. Borings were made by the rotary drilling method on the dates indicated using an auger or drive tube and the standard split spoon sampler. Limestones and Marls were core drilled. Classifications given are field classifications.



MISSISSIPPI STATE HIGHWAY NO. 19 CROSSING
MILE 206.1

E - E

Note:
The borings in this section are plotted as shown on the Miss. State Hwy. boring logs and samples are not available for examination, however, based on information from Attala County Mineral Resources Bul. 99, by Miss. Geological, Economic and Topographical Survey, 1963, it is belived that the lower part of these borings classified as Marls and Limestone are actually the middle Shale member of the Zilpha Formation described as a Clay Shale with Siliceous Silts and Siltstone.

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

GEOLOGIC SECTIONS

SCALE AS SHOWN

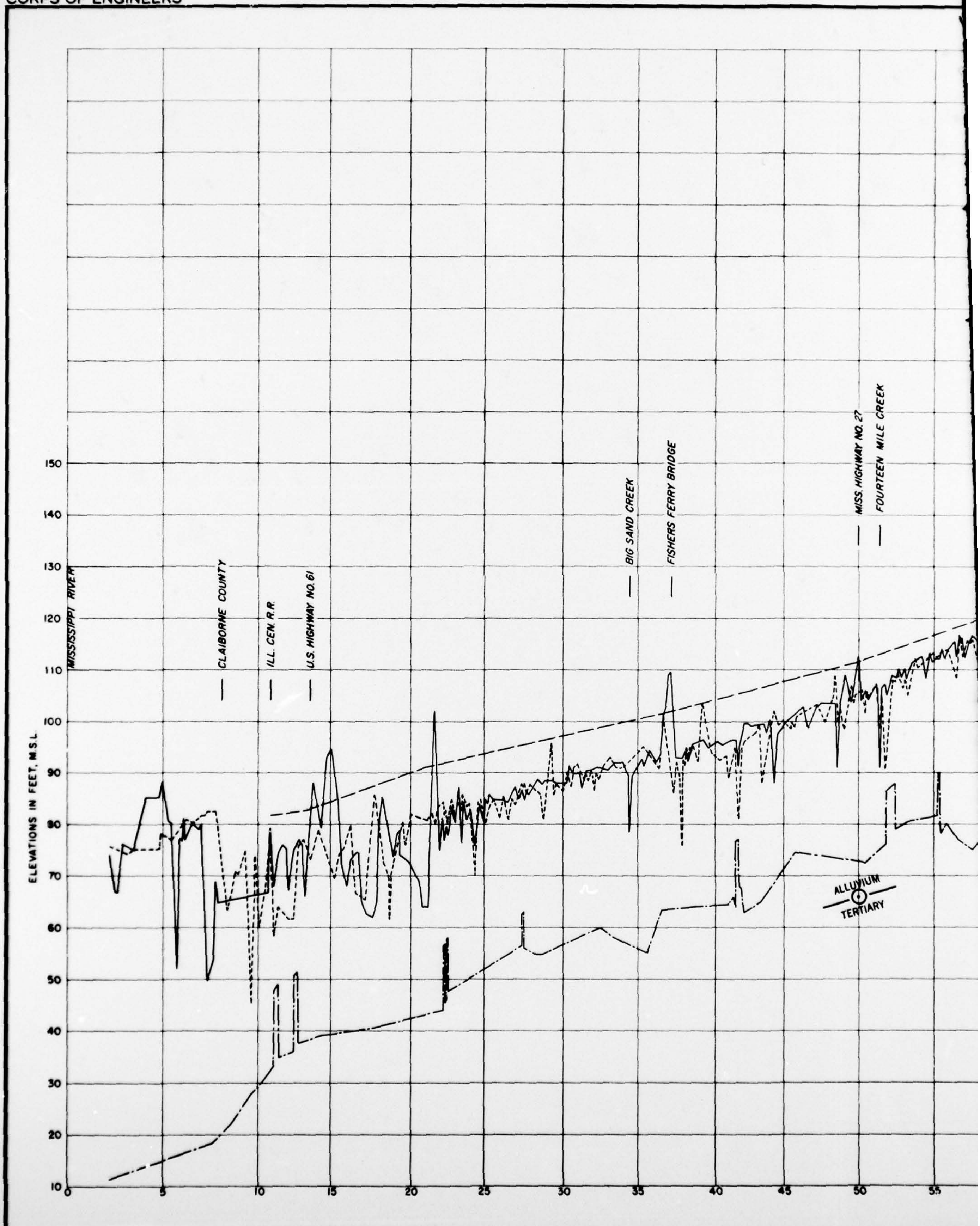
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

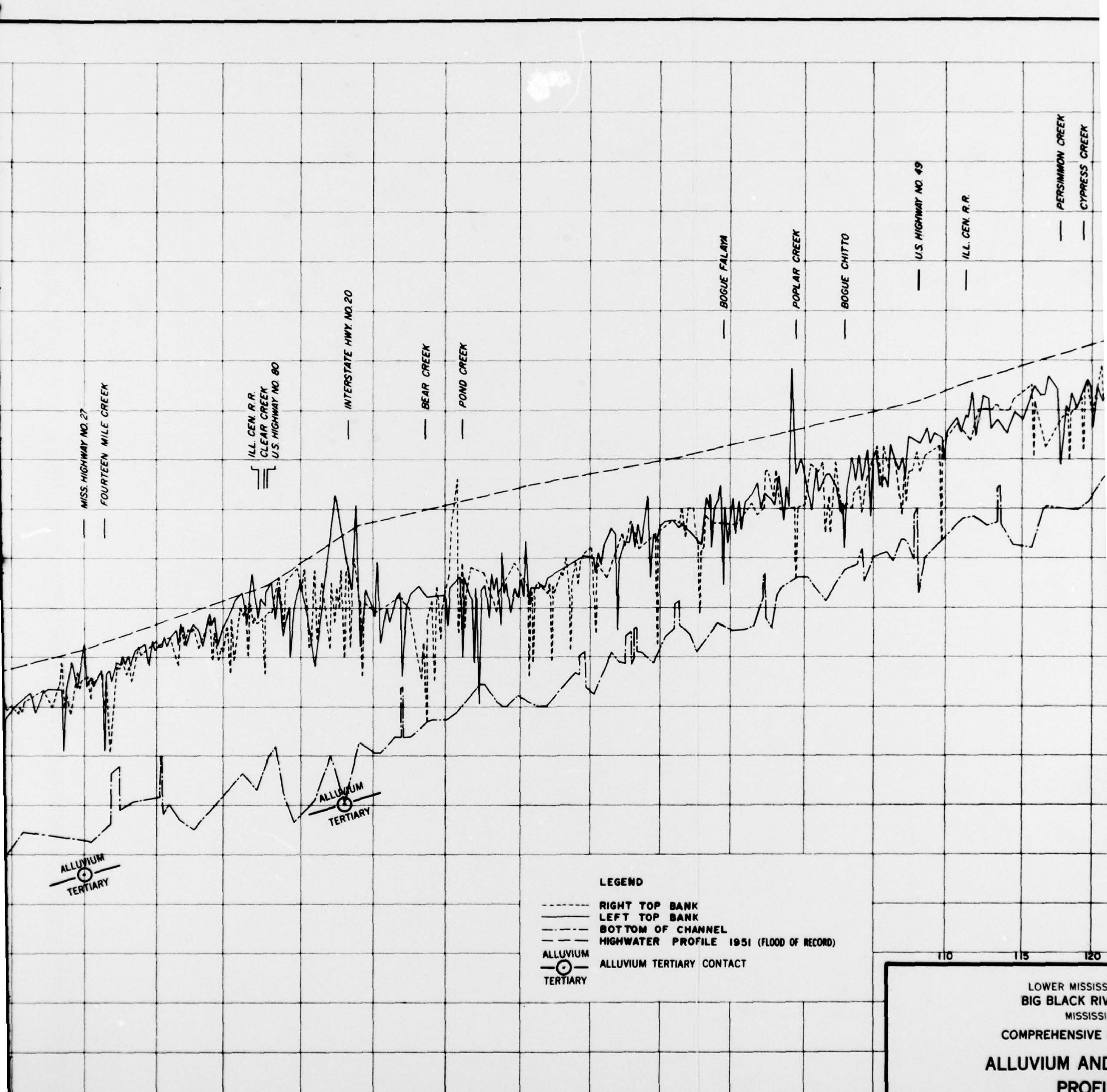
7

FILE NO. BB-14-9

PLATE G-5

CORPS OF ENGINEERS





LOWER MISSISS
BIG BLACK RIV
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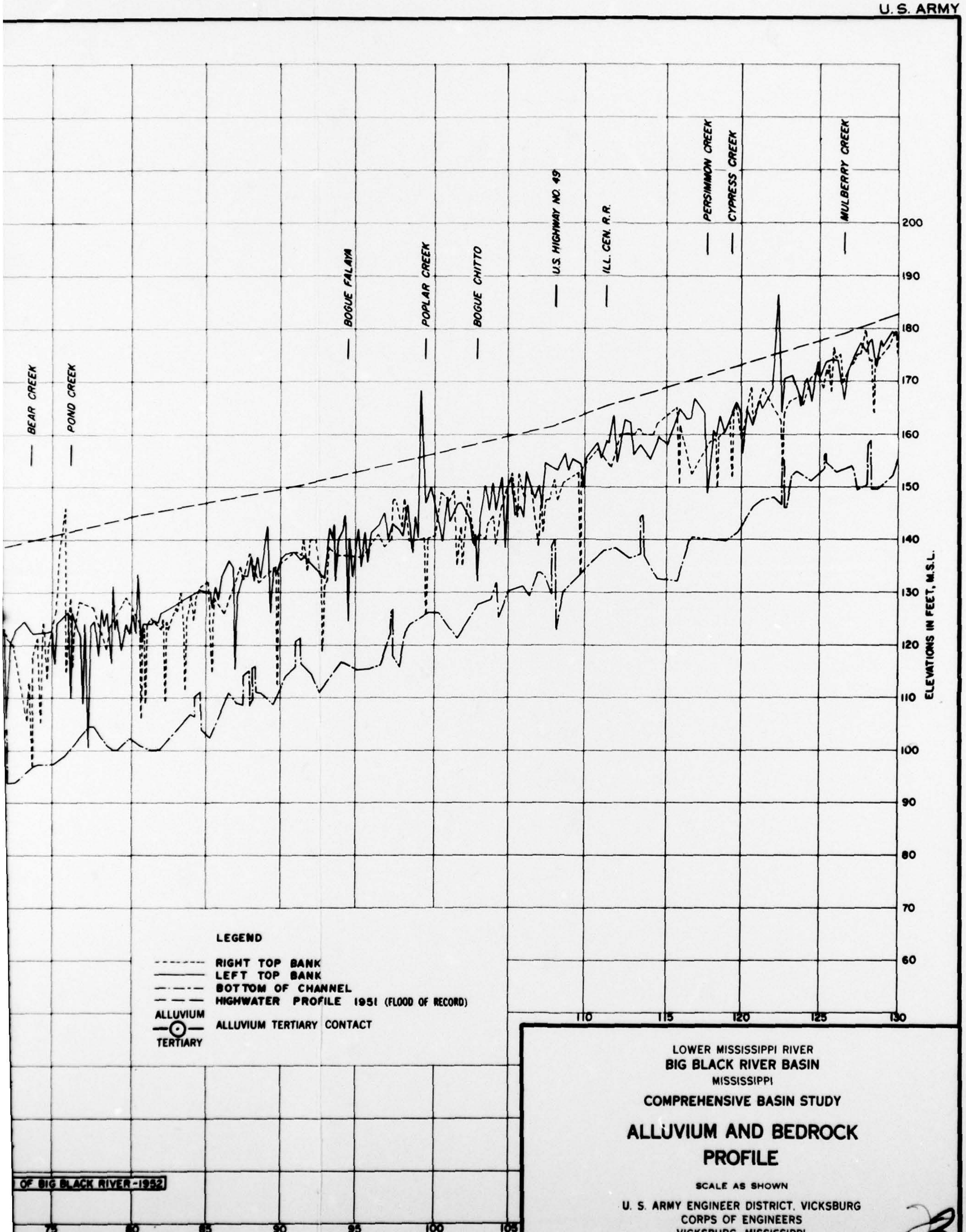
CORPS OF EN
VICKSBURG, MI

2

U. S. ARMY



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

ALLUVIUM AND BEDROCK PROFILE

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

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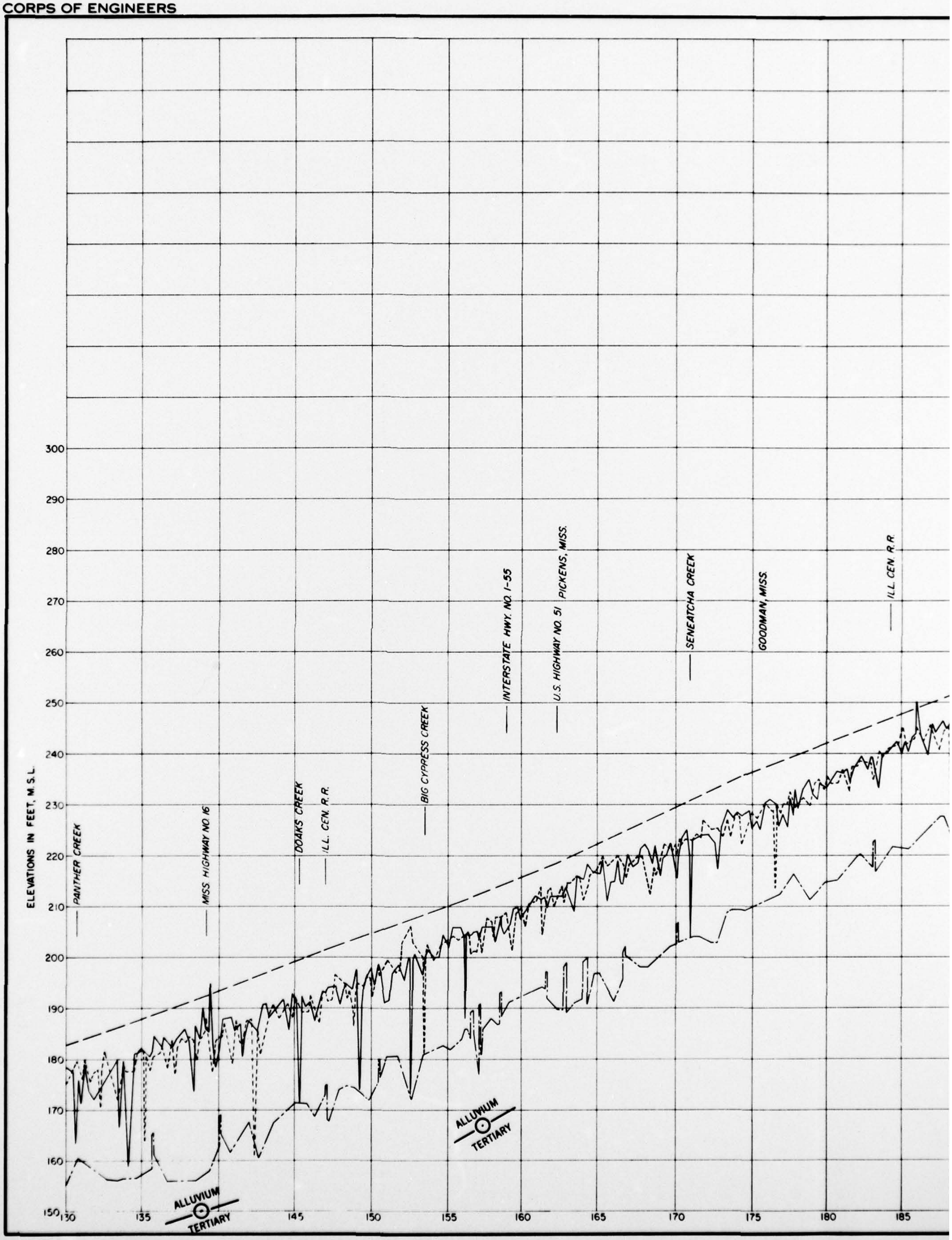
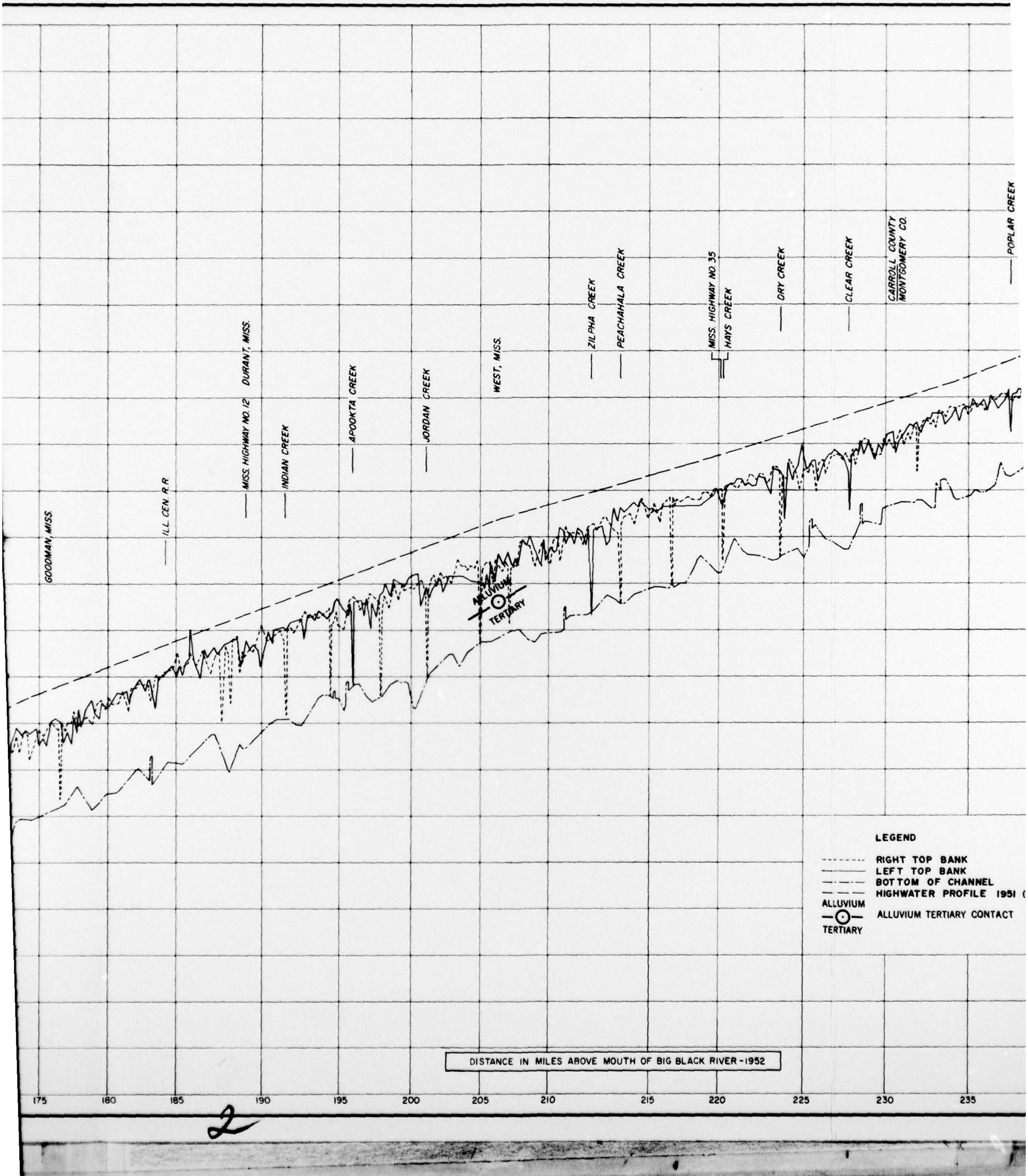
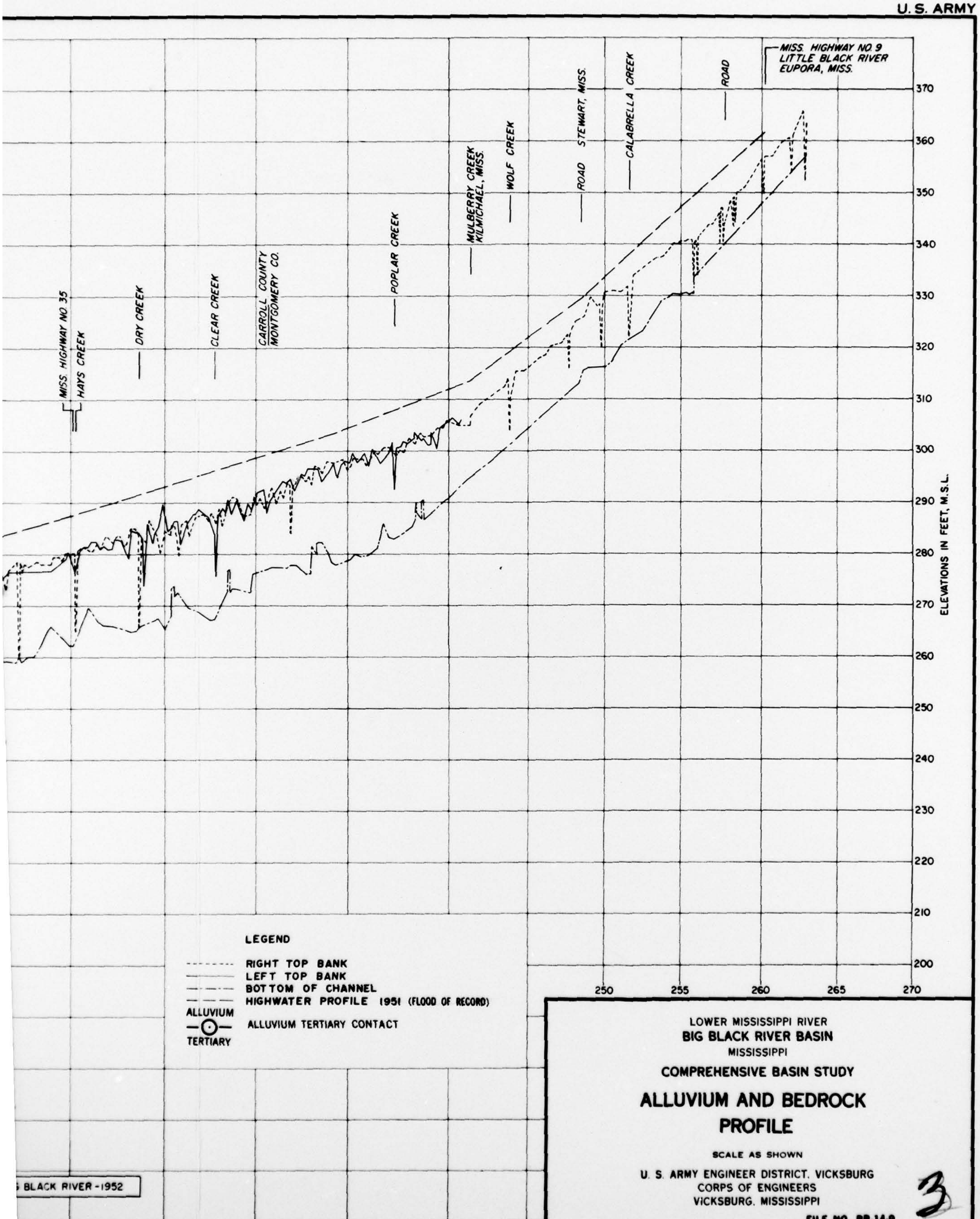
CORPS OF ENGINEERS




GOODMAN, MISS.
ILL. CEN. R.R.
MISS. HIGHWAY NO. 12
DURANT, MISS.
INDIAN CREEK
APOOKTA CREEK
JORDAN CREEK
WEST, MISS.
ZILPHA CREEK
PEACHAHALA CREEK
MISS. HIGHWAY NO. 35
HAYS CREEK
DRY CREEK
CLEAR CREEK
CARROLL COUNTY
MONTGOMERY CO.
POPLAR CREEK
ALLUVIUM
TERTIARY
LEGEND
RIGHT TOP BANK
LEFT TOP BANK
BOTTOM OF CHANNEL
HIGHWATER PROFILE 1951 (
ALLUVIUM
TERTIARY
ALLUVIUM TERTIARY CONTACT
DISTANCE IN MILES ABOVE MOUTH OF BIG BLACK RIVER - 1952
175
180
185
190
195
200
205
210
215
220
225
230
235
2



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI

COMPREHENSIVE BASIN STUDY

ALLUVIUM AND BEDROCK PROFILE

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

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CORPS OF ENGINEERS

UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION		TYPE	LETTER SYMBOL	SYMBOL	TYPICAL NAMES
COARSE - GRAINED SOILS More than half of material is larger than No 200 sieve size	GRAVELS More than half of coarse fraction is larger than No 4 sieve size	CLEAN GRAVEL (Little or No Fines)	GW		GRAVEL, Well Graded, gravel-sand mixtures, little or no fines
			GP		GRAVEL, Poorly Graded, gravel-sand mixtures, little or no fines
		GRAVEL WITH FINES (Appreciable Amount of Fines)	GM		SILTY GRAVEL, gravel-sand-silt mixtures
			GC		CLAYEY GRAVEL, gravel-sand-clay mixtures
	SANDS More than half of coarse fraction is smaller than No 4 sieve size	CLEAN SAND (Little or No Fines)	SW		SAND, Well-Graded, gravelly sands
			SP		SAND, Poorly-Graded, gravelly sands
		SANDS WITH FINES (Appreciable Amount of Fines)	SM		SILTY SAND, sand-silt mixtures
			SC		CLAYEY SAND, sand-clay mixtures
FINE - GRAINED SOILS More than half the material is smaller than No 200 sieve size		SILTS AND CLAYS (Liquid Limit < 50)	ML		SILT & very fine sand, silty or clayey fine sand or clayey silt with slight plasticity
			CL		LEAN CLAY; Sandy Clay; Silty Clay; of low to medium plasticity
			OL		ORGANIC SILTS and organic silty clays of low plasticity
		SILTS AND CLAYS (Liquid Limit > 50)	MH		SILT, fine sandy or silty soil with high plasticity
			CH		FAT CLAY, inorganic clay of high plasticity
			OH		ORGANIC CLAYS of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			Pt		PEAT, and other highly organic soil
WOOD			Wd		WOOD
NO SAMPLE					

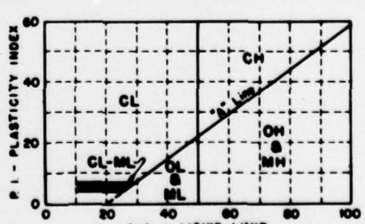
NOTE: Soils possessing characteristics of two groups are designated by combinations of group symbols
A comma will be used between modification symbols. Example: Sa, Gr, w/SS, SIS, (CH)

DESCRIPTIVE SYMBOLS

COLOR	SYMBOL
TAN	T
YELLOW	Y
RED	R
BLACK	BK
GRAY	Gr
LIGHT GRAY	lGr
DARK GRAY	dGr
BROWN	Br
LIGHT BROWN	lBr
DARK BROWN	dBr
BROWNISH-GRAY	br Gr
GRAYISH-BROWN	gyBr
GREENISH-GRAY	gnGr
GRAYISH-GREEN	gyGn
GREEN	Gn
BLUE	Bl
BLUE-GREEN	BlGn
WHITE	Wh
MOTTLED	Mot
REDDISH	rd

CONSISTENCY FOR COHESIVE SOILS

CONSISTENCY	COHESION IN LBS./SQ. FT. FROM UNCONFINED COMPRESSION TEST	SYMBOL
VERY SOFT	< 250	vSo
SOFT	250 - 500	So
MEDIUM	500 - 1000	M
STIFF	1000 - 2000	St
VERY STIFF	2000 - 4000	vSt
HARD	> 4000	H



PLASTICITY CHART

For classification of fine - grained soils

MODIFICATIONS

MODIFICATION	SYMBOL	MODIFICATION	SYMBOL
Traces	Tr-	Sandy Silt strata	SSIS
Fine	F	Silty Sand strata	SISS
Medium	M	With	w/
Coarse	C	Dense	D
Concretions	cc	Very Dense	vD
Rootlets	rt		
Lignite fragments	lg		
Shale fragments	sh		
Sandstone fragments	sds		
Shell fragments	slf		
Organic matter	O		
Clay strata or lenses	CS		
Silt strata or lenses	SIS		
Sand strata or lenses	SS		
Sandy	S		
Gravelly	G		
Boulders	B		
Slickensides	SL		
Wood	Wd		
Oxidized	Ox		
Crumbly	Cr		
Loose	Lo		
Vegetation	Veg		

U. S. ARMY

es
es
ilt with slight plasticity
lasticity
y
silts

group symbols

NOTES:

FIGURES TO LEFT OF BORING UNDER COLUMN "W OR D_{10}"*
Are natural water contents in percent dry weight
When underlined denotes D_{10} size in mm*
FIGURES TO LEFT OF BORING UNDER COLUMNS "LL" AND "PL"
Are liquid and plastic limits, respectively
SYMBOLS TO LEFT OF BORING
∇ Ground-water surface and date observed
(C) Denotes location of consolidation test **
(S) Denotes location of consolidated-drained direct shear test **
(R) Denotes location of consolidated-undrained triaxial compression test **
(Q) Denotes location of unconsolidated-undrained triaxial compression test **
(T) Denotes location of sample subjected to consolidation test and each of the above three types of shear tests **
FW Denotes free water
FIGURES TO RIGHT OF BORING
Are values of cohesion in lbs./sq. ft. from unconfined compression tests
In parenthesis are driving resistances in blows per foot determined with a standard split spoon sampler ($1\frac{3}{8}$" I.D., 2" O.D.) and a 140 lb. driving hammer with a 30" drop
Where underlined with a solid line denotes laboratory permeability in centimeters per second of undisturbed sample
Where underlined with a dashed line denotes laboratory permeability in centimeters per second of sample remoulded to the estimated natural void ratio

* The D_{10} size of a soil is the grain diameter in millimeters of which 10% of the soil is finer, and 90% coarser than size D_{10}.

**Results of these tests are available for inspection in the U.S. Army Engineer District Office, if these symbols appear beside the boring logs on the drawings.

MODIFICATIONS		MODIFICATIONS	
MODIFICATION	SYMBOL	MODIFICATION	SYMBOL
Traces	Tr-	Sandy Silt strata	SSIS
Fine	F	Silty Sand strata	SISS
Medium	M	With	w/
Coarse	C	Dense	D
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Shell fragments	slf		
Organic matter	O		
Clay strata or lenses	CS		
Silt strata or lenses	SIS		
Sand strata or lenses	SS		
Sandy	S		
Gravelly	G		
Boulders	B		
Slickensides	SL		
Wood	Wd		
Oxidized	Ox		
Crumbly	Cr		
Loose	Lo		
Vegetation	Veg		

GENERAL NOTES:

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and, if encountered, such variations will not be considered as differing materially within the purview of clause 4 of the contract.

Ground-water elevations shown on the boring logs represent ground-water surfaces encountered on the dates shown. Absence of water surface data on certain borings implies that no ground-water data is available, but does not necessarily mean that ground water will not be encountered at the locations or within the vertical reaches of these borings.

Consistency of cohesive soils shown on the boring logs is based on driller's log and visual examination and is approximate, except within those vertical reaches of the borings where shear strengths from unconfined compression tests are shown.

LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

SOIL BORING LEGEND

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

2

CORPS OF ENGINEERS

CLASSIFICATION AND DESCRIPTION OF ROCKS

GROUP	SYMBOL	ROCK CLASSIFICATION
SEDIMENTARY ROCKS		CONGLOMERATE
		SANDSTONE
		GRAYWACKE
		SILTSTONE
		INDURATED CLAY OR CLAYSTONE
		COMPACTION SHALE
		CEMENTED SHALE
		COAL
		LIMESTONE
		DOLOMITE
		CHALK (OR MARL)

GROUP	SYMBOL	ROCK CLASSIFICATION
METAMORPHIC ROCKS		GNEISS
		SCHIST
		QUARTZITE
		MARBLE
		SOAPSTONE AND SERPENTINE
		SLATE
IGNEOUS ROCKS		GRANITE
		DIORITE
		GABBRO
		RHYOLITE
		ANDESITE
		BASALT (TRAP)
		TUFF OR TUFF BRECCIA
		AGGLOMERATE FLOW BRECCIA

KEY TO PHYSICAL PROPERTIES

Bedding Characteristics —
1. Massive
2. Thin to medium bedded
3. Fissile
4. Cross — bedded
5. Foliated
6. Platy
7. Fragmental

Lithologic Characteristics —
8. Clayey
9. Shaly
10. Calcareous (limy)
11. Siliceous
12. Sandy
13. Silty
14. Plastic seams
15. Carbonaceous
16. Fossiliferous
17. Ferruginous

Hardness and Degree of Cementation —
18. Very soft or plastic
19. Soft – Can be scratched wi
20. Moderately hard – Can be s with knife, cannot be s fingernail
21. Hard – Difficult to scratch
22. Very hard – Cannot be scra
23. Poorly cemented
24. Cemented

Texture —
25. Dense
26. Fine
27. Medium
28. Coarse

Structure —
29. Bedding a Flat; b Gently; c Steeply
30. Fractures, scattered
31. Fractures, closely spaced
32. Brecciated (sheared & frag
33. Joints
34. Faulted
35. Slickensides

Degree of Weathering —
36. Unweathered
37. Slightly weathered
38. Badly weathered

Solution and Void Conditions —
39. Solid, contains no voids
40. Vuggy (pitted)
41. Vesicular
42. Porous
43. Cavities
44. Cavernous

Swelling Properties —
45. Non – swelling
46. Swelling

Slaking Properties —
47. Non – slaking
48. Slakes slowly on exposure
49. Slakes readily on exposure

OF ROCKS

KEY TO PHYSICAL PROPERTIES OF ROCKS

cteristics	—	1. Massive 2. Thin to medium bedded 3. Fissile 4. Cross — bedded 5. Foliated 6. Platy 7. Fragmental
racteristics	—	8. Clayey 9. Shaly 10. Calcareous (limy) 11. Siliceous 12. Sandy 13. Silty 14. Plastic seams 15. Carbonaceous 16. Fossiliferous 17. Ferruginous
Degree tion	—	18. Very soft or plastic 19. Soft — Can be scratched with fingernail 20. Moderately hard — Can be scratched easily with knife; cannot be scratched with fingernail 21. Hard — Difficult to scratch with knife 22. Very hard — Cannot be scratched with knife 23. Poorly cemented 24. Cemented
	—	25. Dense 26. Fine 27. Medium 28. Coarse
	—	29. Bedding a. Flat; b. Gently dipping; c. Steeply dipping 30. Fractures, scattered 31. Fractures, closely spaced 32. Brecciated (sheared & fragmented) (30–32: a. Open; b. Cemented or tight) 33. Joints 34. Faulted 35. Slickensides
thering	—	36. Unweathered 37. Slightly weathered 38. Badly weathered
ed	—	39. Solid, contains no voids 40. Vuggy (pitted) 41. Vesicular 42. Porous 43. Cavities 44. Cavernous
ties	—	45. Non — swelling 46. Swelling
es	—	47. Non — slaking 48. Slakes slowly on exposure 49. Slakes readily on exposure

NOTE

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND IF ENCOUNTERED, SUCH VARIATIONS WILL NOT BE CONSIDERED AS DIFFERING MATERIALLY WITHIN THE PURVIEW OF CLAUSE 4 OF THE CONTRACT.

GROUND-WATER ELEVATIONS SHOWN ON BORING LOGS REPRESENT GROUND-WATER SURFACES ENCOUNTERED ON THE DATES SHOWN. ABSENCE OF WATER SURFACE DATA ON CERTAIN BORINGS IMPLIES THAT NO GROUND-WATER DATA IS AVAILABLE, BUT DOES NOT NECESSARILY MEAN THAT GROUND WATER WILL NOT BE ENCOUNTERED AT THE LOCATIONS OR WITHIN THE VERTICAL REACHES OF THESE BORINGS.

5 - 50 PRESSURE TEST RESULTS SHOWN AS 5 GALS./MIN. AT 50 PSI

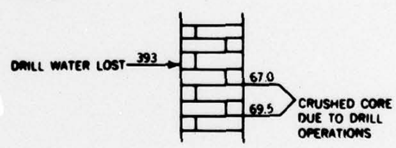
GROUND-WATER SURFACE AND DATE OBSERVED

CORE LOSS OR NO SAMPLE

393 SPECIAL FEATURE OR DRILLING OPERATION AT A SPECIFIC ELEVATION

67.0 / 69.5 SPECIAL FEATURE VERTICALLY DISTRIBUTED

EXAMPLES



LOWER MISSISSIPPI RIVER
BIG BLACK RIVER BASIN
MISSISSIPPI
COMPREHENSIVE BASIN STUDY

ROCK BORING LEGEND

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FILE NO. BB-14-9

2

ATTACHMENT NO. 1

BIG BLACK RIVER BASIN, MISSISSIPPI

INFORMATION CALLED FOR BY
SENATE RESOLUTION 148, 85TH CONGRESS
ADOPTED 28 JANUARY 1958

BIG BLACK RIVER BASIN, MISSISSIPPI
INFORMATION CALLED FOR BY
SENATE RESOLUTION 148, 85TH CONGRESS
ADOPTED 28 JANUARY 1958

1. The result of the Corps of Engineers' investigation for the Big Black River Basin Comprehensive study shows that there is a flooding problem along the main stem of the Big Black River and an unsatisfied need for water-oriented recreation and fish and wildlife.

2. Project evaluation shows that it is not economically feasible at the present time to provide flood protection in the basin by channel improvement, levees, main stem or tributary reservoirs, or any combination of these. Construction of single-purpose recreational reservoirs or inclusion of recreation in a multipurpose reservoir is presently economically feasible. However, Federal participation in recreation projects is limited by law, and does not permit the construction of single-purpose recreation projects by Federal agencies. In addition, major reservoirs would inundate productive farmland and are opposed by local interests.

3. It is therefore recommended that no additional work be undertaken by the Corps of Engineers in the Big Black River Basin at this time.

4. The plans selected for detailed study and presented in the report are: (1) Edwards main stem reservoir; (2) tributary reservoirs; (3) main stem channel improvement--3-year frequency; (4) main stem channel improvement--1-year frequency; (5) Goodman loop levee; and (6) Apookta loop levee. In developing plans for study, consideration was given to all possible alternatives which were engineeringly feasible.

5. In addition to the main stem reservoir presented in the report, reservoirs near West, Mississippi, and in the vicinity of Durant, Mississippi, were investigated and were rejected in the early stages of the study because of high project cost, extensive transportation disruption, and excessive cost involved in the relocation of major highways, railroads, and county road systems, cost and impact of relocating urban areas, and limited benefits that would be realized from the alternatives.

6. In an effort to develop a channel improvement plan on the main stem of the Big Black River, five channel capacities were initially considered. These ranged from an enlargement of the existing channel to a capacity sufficient to contain the 3-year (May-October) frequency flows within banks to clearing and snagging the existing channel. Preliminary investigations indicated that none of the five plans considered would be economically justified. The two plans which would be the most effective in providing flood control and had the best benefit-to-cost ratio in the preliminary evaluation were selected for detailed study.

7. An investigation was made of the bottom lands along the Big Black River to locate areas which might be protected by levees. Seventeen sites were found at which construction of loop levees tieing to the hills would protect areas ranging in size from 1,000 to 2,000 acres. At fifteen of these sites the areas required to impound interior runoff during high stages on the Big Black River would include a large percentage of the area behind the levees. Expensive pumping plants would be necessary to reduce this required sump area. For these reasons, these fifteen sites were eliminated from further consideration. Two of the sites, one near the mouth of Apookta Creek and the other near Goodman, Mississippi, appeared to have suitable sump areas and were analyzed in detail.

8. Cost allocations for the multipurpose reservoirs studied in the report were computed by the separable costs--remaining benefits method. Use of the "Alternative Justifiable Expenditure Method" of the "Use of Facilities Method" of cost allocation will not materially change the results of the economic analysis in the report. Use of either of these methods would increase the cost allocated to flood control in the multipurpose reservoirs, thus lowering the incremental benefit-to-cost ratio of flood control by one-to three-tenths.

9. The reservoir projects studied in the report were evaluated with a 100-year life and the channel improvement and levee projects were evaluated with a 50-year life. Use of a 50-year life for the amortization of cost and calculation of benefits on the reservoir projects would lower the benefit-to-cost ratio approximately three-tenths on the main stem reservoir and six-tenths on the tributary reservoirs. Use of a 100-year life for the channel improvement and levee projects would raise the benefit-to-cost ratios approximately one-tenth.

10. Because of the findings here stated, application of the alternative standards given in Senate Resolution 148 does not provide a basis for findings substantially different from those in the report nor a basis for departure from report recommendations.

DATE
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